

PUBLIC SUBMISSION

As of: January 24, 2012
 Received: January 24, 2012
 Status: Pending_Post
 Tracking No. 80fa2ae1
 Comments Due: January 24, 2012
 Submission Type: Web

Docket: NRC-2008-0369

Environmental Assessment and Finding of No Significant Impact: Watts Bar Nuclear Plant, Unit 2

Comment On: NRC-2008-0369-0016

Draft Supplement 2 to Final Environmental Impact Statement Related to the Operation of Watts Bar Nuclear Plant, Unit 2; Tennessee Valley Authority

Document: NRC-2008-0369-DRAFT-0008

Comment on FR Doc # 2011-32909

Submitter Information

Name: Diane Curran

11/10/2011
76 FR 70169

General Comment

See attached comments.



Attachments

SACE Comments on Watts Bar 2 DEIS 1-24-12

RECEIVED

2012 01 24 PM 3:39

RULES AND DIRECTIVES
STATION
UNIT 2

SUNSI Review Complete
Template = ADM-013

FRIDS = ADM-03
Add = B. Clayton (Boc2)
J. Giguere (S892)
C. Feller (Cxf5)
J. Ford (JCP5)



January 24, 2012

Cindy Bladey, Chief
Rules, Announcements, and Directives Branch
Office of Administration, Mail Stop TWB-05-B01M
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001
Posted on: www.regulations.gov

SUBJECT: *SACE Comments on DEIS for Watts Bar Unit 2, Docket ID NRC-228-0396*

Dear Ms. Bladey:

On behalf of Southern Alliance for Clean Energy ("SACE"), I am writing to submit comments on the Draft Environmental Impact Statement ("DEIS") for the proposed Watts Bar Unit 2 ("WBN2") nuclear power plant. SACE has been admitted as an intervenor in the operating license proceeding for WBN2, where it has raised two important environmental issues that the Tennessee Valley Authority's ("TVA's") Final Supplemental Environmental Impact Statement ("FSEIS") for WBN2 has failed to address or resolve: impacts to the aquatic environment and environmental concerns raised by the Fukushima Accident and the Fukushima Task Force. Because the DEIS does not correct these failures, we believe it violates the National Environmental Policy Act ("NEPA").

Aquatic Impacts. In Contention 7 (which was admitted by the Atomic Safety and Licensing Board ("ASLB") in *Tennessee Valley Authority* (Watts Bar nuclear Plant, Unit 2), LBP-09-26, 70 NRC 939, 981-90 (2009)), SACE has challenged the adequacy of TVA's FSEIS for WBN2 to address the impacts of WBN2 on aquatic organisms. A copy of Contention 7, including the supporting declaration of Dr. Shawn Paul Young, is attached for your consideration as Exhibit 1. Although TVA conducted additional environmental studies that were intended to address our concerns, they are not sufficient to support TVA's claim that the aquatic environmental impacts of WBN2 are insignificant. TVA also distorts the aquatic impacts of WBN2 by characterizing the baseline condition of the Tennessee River as a reservoir rather than a free-flowing river that has been adversely affected by dams and industrialization.

The DEIS has not resolved the issues raised in Contention 7 because it merely adopts the analysis and conclusions of TVA's FSEIS with respect to aquatic impacts. Our continuing concerns about the inadequacy of TVA's environmental analysis are documented in Contention 7 and the attached response by SACE to a recent summary disposition motion by TVA: Southern Alliance for Clean Energy's Opposition to Tennessee Valley Authority's Motion for Summary Disposition of Contention 7 Regarding Aquatic Impacts of Watts Bar Unit 2 and attached Declaration of Shawn Paul Young, Ph.D. A copy of SACE's response to TVA's summary disposition motion is attached for your consideration as Exhibit 2.

Environmental Implications of Fukushima Accident. SACE has also submitted a contention challenging TVA's failure to amend the FSEIS for WBN2 to address the environmental



implications of the Fukushima Task Force Report issued by the NRC in July 2011: Motion to Admit new Contention Regarding the Safety and Environmental Implications of the Nuclear Regulatory Commission Task Force Report on the Fukushima Dai-ichi Accident (August 11, 2011). A copy of our contention, including the supporting declaration of Dr. Arjun Makhijani, is attached for your consideration as Exhibit 3. We are awaiting a ruling on the admissibility of the contention by the ASLB. The concerns raised by the Fukushima Task Force and our contention remain unaddressed by the DEIS, which does not even mention the Fukushima accident.

We believe the deficiencies in outlined in Exhibits 1 through 3 are very grave. By TVA's own admission, the Tennessee River "*is the most diverse temperate freshwater ecosystem in the world.*" Programmatic EIS for Reservoir Operations Study, § 4.7.¹ Neither TVA nor the NRC Staff has grappled with the significance of the impacts of WBN2 to aquatic organisms, and thus they have given no serious consideration to mitigation measures that could protect the fragile and extraordinarily important ecosystem of the Tennessee River.

The NRC's failure to address the environmental implications of the Fukushima Task Force is also extremely grave, given that the Task Force has called for a complete upgrade of the NRC's program for mandatory safety regulations and has targeted WBN2 for specific recommendations. For these reasons, we believe the DEIS fails to satisfy NEPA in significant respects.

Sincerely,

/s/

Diane Curran
Counsel to SACE

¹ http://www.tva.gov/environment/reports/ros_eis/.

BEFORE THE SECRETARY

Docket No. 50-391

I. INTRODUCTION

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

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.")¹⁷

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

¹⁷ 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,

Diane Curran
Matthew D. Fraser
HARMON, CURRAN, SPIELBERG, & EISENBERG, L.L.P.
1726 M Street N.W., Suite 600
Washington, D.C. 20036
202-328-3500
Fax: 202-328-6918
e-mail: dcurran@harmoncurran.com
mfraser@harmoncurran.com

July 13, 2009

December 20, 2011

**UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
BEFORE THE ATOMIC SAFETY AND LICENSING BOARD**

In the Matter of)

Tennessee Valley Authority)

(Watts Bar Unit 2))

Docket No. 50-391-OL

**SOUTHERN ALLIANCE FOR CLEAN ENERGY'S OPPOSITION
TO TENNESSEE VALLEY AUTHORITY'S MOTION
FOR SUMMARY DISPOSITION OF CONTENTION 7 REGARDING
AQUATIC IMPACTS OF WATTS BAR UNIT 2**

I. INTRODUCTION

Pursuant to 10 C.F.R. §§ 2.1205 and the Atomic Safety and Licensing Board's ("ASLB's") orders of May 26, 2010 and December 1, 2011, Southern Alliance for Clean Energy ("SACE") hereby responds to Tennessee Valley Authority's ("TVA's") Motion for Summary Disposition of Contention 7 (Nov. 21, 2011). This response is supported by the attached Statement of Disputed Material Facts and Declaration of Dr. Shawn Young (Dec. 20, 2011) ("Young Declaration").

As discussed below and as demonstrated in the Statement of Disputed Material Facts and Young Declaration, TVA fails to demonstrate that the concerns raised in Contention 7 have been resolved by recent studies conducted by TVA. To the contrary, as discussed in Dr. Young's declaration, although the new data is incomplete and inaccurately analyzed, it shows that Watts Bar Unit 1 ("WBN1") has a significant impact on the environment that will be exacerbated by the operation of Watts Bar Unit 2

("WBN2"). Therefore there is a genuine dispute of material fact between the parties and summary disposition should be denied.

II. STANDARD FOR SUMMARY DISPOSITION

NRC regulations at 10 C.F.R. § 2.1205 govern summary disposition motions and direct Licensing Boards to "apply the standards for summary disposition set forth in Subpart G."¹ Under Subpart G, summary disposition is appropriate if the filings in the proceedings, statements of the parties and affidavits, if any, "show that there is no genuine issue as to any material fact and that the moving party is entitled to a decision as a matter of law."² In a motion for summary disposition, the moving party bears the burden to demonstrate the absence of a genuine issue as to any material fact.³ Any doubt as to the existence of a genuine issue of material fact is resolved against the moving party.⁴ "Because the burden is on the moving party, the Board must examine the record in the light most favorable to the non-moving party and give the non-moving party the benefit of all favorable inferences that can be drawn from the evidence."⁵

A party opposing a motion for summary disposition need not show a likelihood of success on the merits, but rather, only that there is a genuine issue of fact to be evaluated

¹ 10 C.F.R. § 2.1205(c).

² *Id.* § 2.710(d)(2).

³ *Id.* § 2.325; *Advanced Med. Sys., Inc.* (One Factory Row, Geneva, Ohio, 44041), CLI-93-22, 38 NRC 98, 102 (1993); *Entergy Nuclear Vermont Yankee LLC* (Vermont Yankee Nuclear Power Station), LBP-06-5, 63 NRC 116, 121 (2006) (quoting *Private Fuel Storage, LLC* (Independent Spent Fuel Storage Installation), LBP-01-39, 54 NRC 497 (2001)).

⁴ *Entergy Nuclear Vermont Yankee LLC* (Vermont Yankee Nuclear Power Station), LBP-06-5, 63 NRC 116, 121 (2006) (citing *Advanced Med. Sys., Inc.* (One Factory Row, Geneva, Ohio, 44041), CLI-93-22, 38 NRC 98, 102 (1993)).

⁵ *Id.*

at the evidentiary hearing.⁶ Indeed, summary disposition “is not a tool for trying to convince a Licensing Board to decide, on written submissions, genuine issues of material fact that warrant resolution at a hearing.”⁷ A licensing board should not conduct a “trial on affidavits,” but rather “determine whether there is a genuine issue for [hearing].”⁸ In making this determination, “the evidence of the non-movant is to be believed, and all justifiable inferences are to be drawn in his favor.”⁹

Moreover, summary disposition is rarely appropriate when conflicting expert opinions are involved.¹⁰ Indeed, “competing expert opinions present the ‘classic battle of the experts’ and it [is] up to [the finder of fact] to evaluate what weight and credibility each expert opinion deserves.”¹¹ At the summary disposition stage, “[r]egardless of the level of the dispute . . . it is not proper for a Board” to choose which expert has the better of the argument.¹²

⁶ *Advanced Med. Sys., Inc.* (One Factory Row, Geneva, Ohio, 44041), CLI-93-22, 38 NRC 98, 102 (1993)

⁷ *Entergy Nuclear Vermont Yankee LLC* (Vermont Yankee Nuclear Power Station), LBP-06-5, 63 NRC 116, 121 (2006) (quoting *Private Fuel Storage, L.L.C.* (Independent Spent Fuel Storage Installation), LBP-01-39, 54 N.R.C. 497, 509 (2001)).

⁸ *Entergy Nuclear Generation Co. and Entergy Nuclear Operations, Inc.* (Pilgrim Nuclear Power Station), CLI-10-11, 71 NRC 287, 297 (2010).

⁹ *Id.* (quoting *Anderson v. Liberty Lobby*, 477 U.S. 242, 247-48 (1986)).

¹⁰ *Entergy Nuclear Vermont Yankee LLC* (Vermont Yankee Nuclear Power Station), LBP-06-5, 63 NRC 116, 122 (2006) (citing *Phillips v. Cohen*, 400 F.3d 388, 399 (6th Cir. 2005)).

¹¹ *Id.*

¹² *Entergy Nuclear Vermont Yankee LLC* (Vermont Yankee Nuclear Power Station), LBP-06-5, 63 NRC 116, 121 (2006) (citing *Private Fuel Storage, L.L.C.* (Independent Spent Fuel Storage Installation), LBP-01-39, 54 NRC 497, 510 (2001)).

III. ARGUMENT

A. TVA Mischaracterizes the Requirements of NEPA.

With respect to two issues TVA claims that it is entitled to summary disposition as a matter of law under the National Environmental Policy Act (“NEPA”). But TVA misinterprets NEPA and ignores the salient facts of this case. First, TVA asserts that it is permissible under NEPA to use the “current” *i.e.*, degraded condition of the aquatic ecosystem in the Tennessee River near WBN1 and WBN2 as a “baseline” to evaluate the cumulative impacts of WBN2. TVA Motion at 21. In support of this proposition, TVA cites *Calvert Cliffs Unit 3 Nuclear Project, LLC* (Combined License Application for Calvert Cliffs Unit 3), LBP-09-04, 69 NRC 170, 201 (2009), in which the Atomic Safety and Licensing Board (“ASLB”) approved the use of a baseline that effectively constituted a “snapshot” of the current condition of the aquatic environment. But, as the ASLB recognized in *Calvert Cliffs*, NEPA sets no hard and fast rule regarding appropriate baseline conditions and instead calls for application of a “rule of reason.” *Id.* at 203. In each case, the appropriate scope of the baseline for a project is a “functional project: an applicant must provide enough information and in sufficient detail to allow for an evaluation of important impacts.” *Southern Nuclear Operating Co.* (Early Site Permit for Vogtle ESP Site), LBP-07-3, 65 NRC 237, 256 (2007) (citing Office of Nuclear Reactor Regulation, “Standard Review Plans for Environmental Review for Nuclear Power Plants,” NUREG-155 at 4.3.2-1 to -2 (Oct. 1999); office of Nuclear Regulatory Research, General Site Suitability Criteria for Nuclear Power Stations, Regulatory Guide 4.7 at 4.7-14 to -15 (rev. 2, April 1998)).

In *Calvert Cliffs*, the ASLB did not rule out the possibility that past conditions could be relevant to a baseline analysis. 69 NRC at 203. Instead, it found that the petitioners had “not justified requiring individual examination of the environmental effects of reactors located at a substantial distance from the Calvert Cliffs site.”

In this case, SACE has made a very strong case that historic conditions in the Tennessee River are uniquely relevant to the cumulative impacts of WBN2. As discussed in Contention 7, 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.” Petition to Intervene at 33. Moreover, the river “harbors the highest number of imperiled species of any large river basin in North America.” *Id.* TVA does not dispute these assertions. In fact, TVA itself has recognized that the Tennessee River is a unique environmental resource from not just a national perspective but a global one:

Aquatic resources occurring in the TVA region are important from local, national, and global perspectives. Tennessee has approximately 319 fish species, including native and introduced species, and 129 freshwater mussels (Etnier and Starnes 1993), Parmalee and Bogan 1998). The Tennessee-Cumberland Rivers have the highest number of endemic fish, mussel, and crayfish species in North America (Schilling and Williams 2002). *This is the most diverse temperate freshwater ecosystem in the world.*

Programmatic EIS for Reservoir Operations Study, § 4.7.¹³ Clearly, any impacts to an ecosystem that is unique in the entire *planet* for its diversity are “important.” *Southern*, 65 NRC at 256. To accept TVA’s assertion that for purpose of an EIS affecting this unique ecosystem, current deteriorated condition could be considered appropriate for purposes of evaluating impacts and alternatives would be equivalent to pounding nails

¹³ (http://www.tva.gov/environment/reports/ros_eis/).

into its coffin. If the narrow species diversity of a reservoir is considered the baseline for the WBN2 environmental analysis, then any hope of mitigation measures to sustain or restore the vestiges of diversity that remain will be effectively extinguished by the environmental analysis whose purpose is to protect the environment.

For instance, as Dr. Young discusses in his Declaration in Section F, TVA operates the dams and the power plants on the Tennessee River as a single system. This system includes ten different tributaries with a high number of fish and mussel species. By failing to use a baseline that takes into account the fragile health of these tributaries, TVA effectively writes off any mitigation measures that could aid their survival and consigns them to oblivion. This is the type of blindered and harmful decision-making that NEPA was intended to avoid. *Robertson*, 490 U.S. at 349. Such a result would be all the more egregious in light of the fact that the indefinite existence of dams on major rivers is no longer a foregone conclusion. As reported on the American Rivers website, over 600 dams in the U.S. have been removed over the past 50 years.¹⁴

The licensing and operation of WBN2 is just one of many industrial projects that will affect the aquatic health of the Tennessee River. If TVA and the NRC are allowed to ignore the true baseline condition of the river in the EIS for Watts Bar, then not only is any opportunity for mitigation of the effects of WBN2 lost, but future decisions will be affected by the bad assumptions of these EISs. That outcome is not consistent with the purposes of NEPA.

¹⁴ <http://www.americanrivers.org/our-work/restoring-rivers/dams/projects/2011-dam-removal-resource-guide.html>.

TVA also asks the ASLB to dismiss SACE's claim that TVA fails to show that it accounted for the hydrothermal impacts of overflow from the holding pond, on the ground that the holding pond has never been used. TVA Motion at 19. According to TVA, this shows that use of the holding pond is a "worst case scenario" which need not be addressed under Supreme Court precedent. *Id.* (citing *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 354-55 (1989)). This argument is absurd. Clearly, TVA anticipated that a holding pond might be needed, otherwise TVA would never have included a holding pond in its design. Thus, the potential need for the holding pond can hardly be characterized as "speculative." TVA Motion at 19. TVA's argument therefore should be rejected.

B. TVA Has Failed To Demonstrate that Facts Material to the Claims Of Contention 7 are Undisputed.

1. Claims of Contention 7

Contention 7 challenges the adequacy of TVA's Final Supplemental Environmental Impact Statement ("FSEIS") for the proposed Watts Bar Unit 2 nuclear power plant ("WBN2"). Contention 7 disputes the reasonableness of the FSEIS' conclusion that the cumulative impacts of WBN2 on the aquatic ecology of the Tennessee River are insignificant in three 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 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.

2. Summary disposition of Contention 7 is inappropriate because material facts are in dispute.

TVA claims that it has conducted studies that resolve the three major deficiencies identified in Contention 7. As discussed in Dr. Young's attached Declaration, this is not correct. With respect to the inadequacy of TVA's previous data and analyses, TVA has made some progress by collecting new data on entrainment, impingement, freshwater mussels, and thermal impacts during 2010. But TVA has only started to catch up with its failure to collect the appropriate data that would be reasonably sufficient to evaluate impacts on aquatic resources by collecting only one year of data for entrainment, impingement, freshwater mussels, and thermal impacts over the preceding years. TVA still has not collected an amount of data that is reasonably necessary to evaluate the effects of WBN1 on aquatic organisms in the Tennessee River, and therefore it does not have enough information to extrapolate the impacts of WBN2. Young Declaration, par. II-2.

In addition, there are still big gaps in the information that TVA has collected. For example, TVA collected entrainment data for the Condenser Cooling Water ("CCW") system only and did not include the Supplemental Condenser Cooling Water ("SCCW") system. In addition, TVA did not collect impingement data for all key locations. And TVA's Hydrothermal Study does not address important parameters such as Outfall 101 or the amount of time that fish larvae remain in the thermal plume. Young Declaration, par. II-3.

Finally, TVA's description of its method of analyzing aquatic impacts indicates a troubling lack of care or competence. For example, by adding widely divergent diurnal and nocturnal entrainment measurement, TVA violates guidance of the U.S. Environmental Protection Agency ("EPA") and grossly overstates the size and diversity of the fish population. Some of the studies relied on by TVA had to be revised after they were released, indicating that TVA has significant problems ensuring the quality of its measurements and analyses. It is reasonable to expect that the results from TVA's biological studies will be accurate in order to support TVA's conclusions. In too many instances, however, TVA makes significant mistakes. Young Declaration, par. II-4.

With respect to TVA's mischaracterization of the health of the aquatic environment as good, TVA has done nothing to alleviate the concerns raised by Contention 7. Although as discussed above, TVA's data collection is insufficient to present a reasonable picture of the health of the Tennessee River, the data that TVA has collected do not indicate, as TVA claims, that WBN1's impacts on the aquatic ecosystem have been insignificant. Rather, they point to already-significant aquatic impacts by WBN1 that are likely to be significantly exacerbated by the operation of WBN2. Young Declaration, par. II-5.

Further, despite alarming evidence of significant decline in the diversity and numbers of aquatic organisms in the Tennessee River in the vicinity of WBN, TVA continues to assert that the aquatic health of the river is good. The only way that TVA can present such a clean bill of health is to mischaracterize the baseline condition of the Tennessee River as a large reservoir where one would expect to see a limited number of

species of aquatic organisms. In reality, the Tennessee River is a fragile and rapidly deteriorating riverine ecosystem with remnants of the greatest species diversity of any river in the United States. By falsely painting a rosy picture of aquatic health in the river, TVA understates the significance of the impacts of WBN1 and WBN2, and thus minimizes the benefits that could be achieved by implementing alternatives that would reduce the impacts of the cooling system on organisms in the river. Young Declaration, par. II-6.

Finally, TVA still does not 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. The combined operation of WBN1 and WBN2, by itself, may cause changes in how Watts Bar Dam is operated. TVA and the NRC Staff both acknowledge that in order to stay within thermal discharge limits stated in the NPDES that requests for additional discharge from Watts Bar Dam may be needed. Thus, operating WBN alone would change reservoir operations in the middle- Tennessee Basin that would be supported by water releases or hydrological adjustments in upper- Tennessee River Basin. The effects of more alterations to the hydrological cycle of the basin on aquatic organisms, especially the already declining native fish and freshwater mussel species, must be addressed. Given the extensive portfolio of energy and industrial facilities that the Tennessee River supports and that the management agencies must

maintain adequate water for all these facilities, this is an extremely important omission.

Young Declaration, par. II-7.

TVA's claims are also contradicted by the NRC Staff's Draft Supplemental Environmental Statement ("DSES") for WBN2. TVA claims, for instance, that WBN Unit 1 was originally designed to operate only in a closed cycle cooling mode via the Condenser Cooling Water ("CCW") system. After TVA began operation of Unit 1, it determined that a supplemental cooling system would increase the efficiency of the plant. Accordingly, TVA began to use a Supplemental Condenser Cooling Water ("SCCW") system in 1998. Disputed as to the reason TVA began to use the SCCW. The original cooling system was under-designed and would have prevented WB1 from achieving rated power output on hot summer days. Some form of cooling tower enhancement or supplemental cooling was/is necessary for WB1 to achieve rated output on hot summer days (when the highest annual demand is experienced on the TVA system). This is supported by the NRC's Draft SFEIS at page 3-4, which states:

Evaporation of cooling-water system water from the cooling-tower increases the concentration of dissolved solids in the cooling-water system. In most closed-cycle wet cooling systems, a portion of the cooling water is removed and replaced with makeup water from the source (for WBN, the Tennessee River) to limit the concentration of dissolved solids in the cooling system and in the discharge to the receiving water body.

Because the WBN cooling tower cannot remove the desired amount of heat from the circulating water during certain times of the year, TVA added the Supplemental Condenser Cooling Water (SCCW) system to the cooling system for the WBN reactors (TVA 1998). The SCCW draws water from behind Watts Bar Dam and delivers it, by gravity flow, to the cooling-tower basins to supplement cooling of WBN Unit 1. This cooling system would also be used for Unit 2. The temperature of this water is usually lower than the temperature of the water in the cooling-tower basin and, as a result, lowers the temperature of the water being used to cool the steam in the condensers. Slightly less water enters the cooling-

tower basins through the SCCW intake than leaves the cooling-tower basins and is discharged to the Tennessee River through the SCCW discharge structure (TVA, 2010). *Since the SCCW has been operating, elevated total dissolved solids in blowdown water have not been a concern because a large volume of water continually enters and leaves the cooling-tower basins* (PNNL 2009).

(emphasis added). Had TVA more robust cooling system in the first place, the SCCW would never have been considered necessary by TVA and TVA would not now be proposing to operate WBN2 with the SCCW.

Accordingly, all of the allegedly undisputed material facts alleged by TVA are disputed by SACE. Therefore summary disposition of Contention 7 is inappropriate.

B. TVA's Studies Have Not Mooted Contention 7.

TVA argues that Contention 7 is “fundamentally a contention of omission.” Motion at 1. Therefore, according to TVA, the ASLB should dismiss Contention 7 because it has now performed the studies demanded by the contention. *Id.* TVA contradicts its own argument, however, by conceding that the contention claims that TVA's aquatic studies were “inadequate and outdated.” *Id.* Indeed, the contention itself repeatedly refers to the inadequacy of TVA's discussion 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. S2, and Table 2-1 at page. 30). *TVA's conclusion is not reasonable or adequately supported*, and therefore 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 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.

Petition to Intervene and Request for Hearing at 31-32 (July 13, 2009) (emphasis added). A discussion of the inadequacy and inaccuracy of TVA's studies also runs throughout the basis for the contention. *See id.* at 32 ("TVA's finding that WBN Unit 2 will have no significant impacts on aquatic life in the Tennessee River is inadequately supported"); *id.* at 33 ("TVA incorrectly portrays the ecosystem as healthy"); *id.* at 33 ("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"); *id.* (TVA relies on "poor and out dated data, distorted interpretations of data, and assumptions and extrapolations in lieu of recent monitoring studies"); *id.* at 34 ("TVA has not collected sufficient data to understand the distribution of ichthyoplankton populations or how they are affected by Watts Bar intakes") *id.* (TVA's conclusion that entrainment impacts are insignificant is based upon an unsupported assumption"); *id.* at 36 ("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). Thus, both the plain language and the context of the contention show that it is a contention of adequacy, not omission. *Southern Nuclear Operating Co.* (Early Site Permit for Vogtle ESP Site), LBP-08-2, 67 NRC 54, 65 (2008). Accordingly, contrary to TVA's arguments, SACE was not required to amend the contention to address each study that TVA prepared in order to maintain the viability of Contention 7.

IV. CONCLUSION

For the foregoing reasons, the ASLB should deny TVA's Motion for Summary Disposition of Contention 7.

Respectfully submitted,

Electronically signed by

Diane Curran

HARMON, CURRAN, SPIELBERG, & EISENBERG, L.L.P.

1726 M Street N.W., Suite 600

Washington, D.C. 20036

202-328-3500

Fax: 202-328-6918

e-mail: dcurran@harmoncurran.com

December 20, 2011

December 20, 2011

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of)

Tennessee Valley Authority)

(Watts Bar Unit 2))

Docket No. 50-391-OL

**SOUTHERN ALLIANCE FOR CLEAN ENERGY'S
STATEMENT OF DISPUTED MATERIAL FACTS**

Southern Alliance for Clean Energy ("SACE") respectfully submits the following statement of disputed material facts in response to Tennessee Valley Authority's ("TVA's") Statement of Material Facts on Which No Genuine Issue Exists (Nov. 21, 2011). SACE responds as follows:

I. Procedural Background

A. Licensing History for Watts Bar Nuclear Plant

1. On May 14, 1971, TVA applied for a Construction Permit ("CP") for the Watts Bar Nuclear Plant ("WBN"). The NRC issued CPs for WBN Units 1 and 2 on January 23, 1973, and construction began. TVA substantially completed construction of Unit 1 in 1985. **Undisputed.**

2. On June 30, 1976, TVA first filed an application for an operating license ("OL") for WBN Units 1 and 2. On February 7, 1996, the NRC issued an OL for Unit 1 that authorized operation at 100% power. **Undisputed.**

3. Between 1973 and 2008, the NRC extended the CP for Unit 2 on several occasions. During this time, TVA maintained WBN Unit 2 in deferred plant status, in accordance with the NRC's "Policy Statement on Deferred Plants." **Undisputed.**

4. On August 3, 2007, TVA informed the NRC Staff its intention to resume and complete construction of WBN Unit 2. TVA updated its original OL application for WBN Unit 2 on March 4, 2009, prompting the NRC to publish a notice of hearing in the Federal Register on May 1, 2009. **Undisputed.**

5. Throughout this time, TVA and the NRC completed a number of environmental reviews of WBN. On November 9, 1972, TVA issued a Final Environmental Statement for WBN Units 1 and 2 ("TVA 1972 FES"). On December 1, 1978, the NRC issued its Final Environmental Statement evaluating the operation of Units 1 and 2 ("NRC 1978 FES"). The NRC supplemented its 1978 FES on April 1, 1995 ("NRC 1995b"), in order to re-examine environmental considerations before issuing an OL for WBN Unit 1. **Undisputed.**

6. When TVA reactivated construction of WBN Unit 2, it also submitted its Final Supplemental Environmental Impact Statement ("2007 FSEIS") to the NRC on February 15, 2008. The NRC published its draft supplement to the final environmental statement ("Draft SFES") on October 31, 2011. **Undisputed.**

B. Intervention in Current Proceeding

7. After TVA updated its OL application for WBN Unit 2 and the NRC issued a Notice of Opportunity for Hearing on May 1, 2009, five organizations (Southern Alliance for Clean Energy ("SACE"), Tennessee Environmental Council, We the People, the Sierra Club, and Blue Ridge Environmental Defense League) jointly filed a Petition to Intervene and Request for Hearing, which included seven contentions. Among those, Contention 7 challenged TVA's analysis of the impact of operation of WBN Unit 2 on the aquatic environment. In Contention 7, SACE alleged:

TVA claims that the cumulative impacts of WBN Unit 2 on aquatic ecology will be insignificant (FSEIS Table S-1 at page. S2, and Table 2-1 at page. 30). [sic] TVA's conclusion is not reasonable or adequately supported, and therefore 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 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. **Undisputed.**

8. The NRC Staff and TVA subsequently filed answers addressing the Petition. On September 3, 2009, SACE filed a Motion for Leave to Amend Contention 7, along with an Amended Contention 7. Both TVA and the NRC Staff filed responses opposing SACE's Motion and Answers to the Amended Contention. SACE thereafter filed a reply to the Answers to the Amended Contention on October 5, 2009. **Undisputed.**

9. On November 19, 2009, this Board granted the Petition to Intervene on behalf of SACE, admitting two contentions. The Board denied SACE's Motion to Amend Contention 7, instead admitting Contention 7 as originally presented. Although the Board admitted Contention 1 along with Contention 7, TVA moved to dismiss Contention 1 as moot on April 19, 2010. The Intervenor did not oppose that motion, and the Board granted TVA's unopposed Motion and dismissed Contention 1 accordingly. As a result, only Contention 7 remains to be resolved. **Undisputed.**

C. New Information on the Record – TVA's Aquatic Studies and NRC's Draft SFES

10. In direct response to the issues raised by SACE in Contention 7, TVA collected extensive new data on the current health of the aquatic environment and the impact of operation

of WBN Unit 1 on that environment, prepared numerous updated and expanded aquatics-related analyses, documented the analyses in published reports and studies, and disclosed these reports and studies to the NRC Staff and SACE. **Undisputed except with respect to TVA's characterization of the data as "extensive." As discussed throughout Dr. Young's Declaration, there are significant gaps and inadequacies in the data.**

A complete list of those studies, including the dates that TVA disclosed each to SACE and the NRC Staff, follows:

- a. Comparison of Fish Species Occurrence and Trends in Reservoir Fish Assemblage Index Results in Chickamauga Reservoir Before and After [WBN] Unit 1 Operation (June 2010) ("RFAI Study"), which TVA disclosed to SACE and the NRC Staff on July 15, 2010;
 - b. Analysis of Fish Species Occurrences in Chickamauga Reservoir – A Comparison of Historic and Recent Data (Oct. 2010) ("Fish Species Order (Granting TVA's Unopposed Motion to Dismiss SACE Contention 1) (June 2, 2010) (unpublished). Occurrences Study"), which TVA disclosed to SACE and the NRC Staff on November 15, 2010;
 - c. Mollusk Survey of the Tennessee River Near [WBN] (Rhea County, Tennessee) (Nov. 2010) ("Mollusk Survey"), which TVA disclosed to SACE and the NRC Staff on January 18, 2011;
 - d. Discussion of the Results of the 2010 Mollusk Survey of the Tennessee River Near [WBN] (Rhea County, Tennessee) (Mar. 2011) ("Discussion of Mollusk Survey"), which TVA disclosed to SACE and the NRC Staff on March 15, 2011;
 - e. Aquatic Environmental Conditions in the Vicinity of [WBN] During Two Years of Operation, 1996-1997 (June 1998, Revised June 2010) ("Revised Aquatics Study"), which TVA disclosed to SACE and the NRC Staff on July 15, 2010;
 - f. Comparison of 2010 Peak Spawning Seasonal Densities of Ichthyoplankton at [WBN] at Tennessee River Mile 528 with Historical Densities during 1996 and 1997 (Apr. 2011, Revised Nov. 2011) ("Peak Spawning Entrainment Study"), which TVA disclosed to SACE and the NRC Staff on April 15, 2011;
 - g. Fish Impingement at [WBN] Intake Pumping Station Cooling Water Intake Structure during March 2010 through March 2011 (Mar. 2011, Revised Apr. 2011) ("Impingement Study"), which TVA disclosed to SACE and the NRC Staff on May 16, 2011; and
 - h. Hydrothermal Effects on the Ichthyoplankton from the [WBN] Supplemental Condenser Cooling Water Outfall in Upper Chickamauga Reservoir (Jan. 2011) ("Hydrothermal Study"), which TVA disclosed to SACE and the NRC Staff on February 15, 2011. **Undisputed.**
11. SACE has not raised any concerns with respect to these studies with the NRC or this Board. **Undisputed.**
12. The NRC Staff's Draft SFES, dated October 31, 2011, concurs with TVA's findings in its aquatics studies. Section IV, below, discusses the specific conclusions drawn by the Staff that are relevant to TVA's aquatic studies. **Undisputed.**

II. Description of the Proposed Project

A. General Information

13. The WBN site is located in Rhea County, Tennessee, on the west bank of the Tennessee River, in the upper Chickamauga Reservoir at Tennessee River Mile ("TRM") 528. **Undisputed.**

14. The Tennessee River System is approximately 650 miles long and is comprised of riverine and lacustrine environments, created by numerous dams and locks on the system, most of which have been in place since the 1940s. Chickamauga Dam, completed in 1940 at TRM 471, impounds Chickamauga Reservoir downstream of WBN. Watts Bar Hydroelectric Dam impounds the Watts Bar Reservoir 1.9 miles upstream of WBN. **Undisputed.**

15. The Tennessee River is also host to numerous industrial facilities. For example, WBN is located approximately one mile downstream of the decommissioned Watts Bar Fossil Plant. **Undisputed.**

16. TVA is the licensee and operator of the existing WBN Unit 1, a Westinghouse pressurized water reactor that began full commercial operation on May 27, 1996. **Undisputed.**

17. WBN Unit 1 was originally designed to operate only in a closed cycle cooling mode via the Condenser Cooling Water ("CCW") system. After TVA began operation of Unit 1, it determined that a supplemental cooling system would increase the efficiency of the plant. Accordingly, TVA began to use a Supplemental Condenser Cooling Water ("SCCW") system in 1998. **Disputed as to the reason TVA began to use the SCCW. The original cooling system was under-designed and would have prevented WB1 from achieving rated power output on hot summer days. Some form of cooling tower enhancement or supplemental cooling was/is necessary for WB1 to achieve rated output on hot summer days (when the highest annual demand is experienced on the TVA system). This is supported by the NRC's Draft SFEIS at page 3-4, which states:**

Evaporation of cooling-water system water from the cooling-tower increases the concentration of dissolved solids in the cooling-water system. In most closed-cycle wet cooling systems, a portion of the cooling water is removed and replaced with makeup water from the source (for WBN, the Tennessee River) to limit the concentration of dissolved solids in the cooling system and in the discharge to the receiving water body.

Because the WBN cooling tower cannot remove the desired amount of heat from the circulating water during certain times of the year, TVA added the Supplemental Condenser Cooling Water (SCCW) system to the cooling system for the WBN reactors (TVA 1998). The SCCW draws water from behind Watts Bar Dam and delivers it, by gravity flow, to the cooling-tower basins to supplement cooling of WBN Unit 1. This cooling system would also be used for Unit 2. The temperature of this water is usually lower than the temperature of the water in the cooling-tower basin and, as a result, lowers the temperature of the water being used to cool the steam in the

condensers. Slightly less water enters the cooling-tower basins through the SCCW intake than leaves the cooling-tower basins and is discharged to the Tennessee River through the SCCW discharge structure (TVA, 2010). *Since the SCCW has been operating, elevated total dissolved solids in blowdown water have not been a concern because a large volume of water continually enters and leaves the cooling-tower basins* (PNNL 2009).

(emphasis added). Had TVA more robust cooling system in the first place, the SCCW would never have been considered necessary by TVA and TVA would not now be proposing to operate WBN2 with the SCCW.

18. The present proceeding pertains to the OL for WBN Unit 2. The added operation of WBN Unit 2 may result in minimal increased demands on that aquatic environment both for cooling water intake and cooling water discharge. **Disputed as to the term “minimal.”** As discussed in Dr. Young’s Declaration throughout, the already-stressed Tennessee River aquatic environment will be further stressed by additional CCW intake and discharge and increased SCCW discharge to accommodate the operation of both WB1 and WB2 cooling towers and the increased cumulative cooling tower blowdown discharge to the Tennessee River as a result of WB2 operation. The combined operation of two units will have substantial impacts on the Tennessee River.

B. WBN Cooling System Intake

19. WBN Unit 2 shares intake channels with Unit 1. Operation of Unit 1 withdraws cooling water from CCW and SCCW intake channels. Under dual unit operation, WBN will continue to draw cooling water from the CCW and SCCW intake channels. **Undisputed.**

20. The SCCW system is gravity driven. As a result, intake flow and velocity for the SCCW depends on the water level behind the Watts Bar Dam. **Undisputed.**

21. Flow through the CCW is driven by the IPS, rather than gravity. The IPS will draw more water at a higher flow rate under dual unit operation than for operation of Unit 1 alone. CCW maximum intake velocities will not increase under dual unit operation because the intake will draw water through additional openings. **Undisputed.**

22. Studies show that the hydraulic entrainment from dual unit operation will result in an additional entrained amount of 0.2% of the flow in the Chickamauga Reservoir. The resulting total hydraulic entrainment represents approximately 0.5% of the flow in the Chickamauga Reservoir. This increased hydraulic entrainment will result in a proportionate increase in entrainment of the ichthyoplankton present in the water column. **Disputed as to this calculation is only partly correct, and only accurate at a very specific river flow past WBN Plant. As discussed in Dr. Young’s Declaration at par. III-A.13-14, the 0.2% hydraulic entrainment for WB1 is based upon TVA using a long term average river flow past WBN of 27,000 cfs. Using 3,500 cfs, which is the minimum amount of flow from Watts Bar Dam that permits TVA to discharge thermal and chemical effluent through Outfall 101, the hydraulic entrainment increases to 2.1% (10 times higher). Then, with the addition of Unit 2 almost doubling hydraulic entrainment, the hydraulic entrainment at a flow of 3,500 cfs further increases to approximately 4.0% (20 times higher). Also, only data collected by field studies**

in combination with proper methods for calculation may accurately characterize ichthyoplankton entrainment under any level of hydraulic entrainment.

23. Studies show that CCW flow rates resulting from dual unit operation will average 134 cubic feet per second (“cfs”) at summer pool levels and 113 cfs at winter pool levels, an increase from those rates observed under operation of Unit 1 alone: 73 cfs and 68 cfs, respectively. (The maximum intake velocities will not change under dual unit operation because of the additional IPS openings available to accommodate increased flow.) The increased flow rates in the CCW intake channel resulting from dual unit operation will result in a proportionate increase in the rates of fish impingement. **Disputed. It is important to note that TVA identifies the makeup flow through the IPS as 174 fps, double the withdrawal from the Tennessee River that would occur with only WBN1 online, and an increase in warm blowdown discharge to the Tennessee River from 135 cfs to 170 cfs, a 26 percent increase. These are substantial increases, independent of the role of the SCCW. See Table 3-1 of the DFES, at page 3-9:**

	WB1&WB2	WB1 only
Blowdown rate when diffusers are discharging from cooling towers and YHP	4.81 m ³ /s (170 cfs) ^(b)	3.82 m ³ /s (135 cfs) ^(b)
IPS makeup flow	4.93 m ³ /s (174 cfs) ^(c)	2.5 m ³ /s (88 cfs)
SCCW		
Intake flow rate	7.1 m ³ /s (250 cfs)	7.31 m ³ /s (258 cfs)
Discharge flow rate	8.46 m ³ /s (299 cfs)	7.48 m ³ /s (264 cfs)

The rates of fish impingement may exponentially increase. Similar to the issue of hydraulic versus ichthyoplankton entrainment, only field monitoring will accurately determine impingement rates. See Young Declaration, ¶¶ III-A.13-14.

C. WBN Cooling System Output

24. WBN Unit 2 shares cooling water discharge outfalls with Unit 1. **Undisputed.**

25. The thermal discharge from WBN operation is bound by thermal limits established by TVA’s NPDES permit. The NPDES system establishes legally enforceable, aquatic health-based limits on hydrothermal discharges, in accordance with state and federal statutes. The Tennessee Water Pollution Control Division (“TDEC”) issued a new NPDES permit for the operation of WBN Units 1 and 2 on June 30, 2011, most recently revised on August 31, 2011. **Undisputed, except for the facts that the existence of a legal limit does not ensure there will be no significant impacts to aquatic organisms and is not a guarantee that the operation will stay within the limit.**

26. TVA’s NPDES permit sets discharge limits for each of the WBN outfall points under operation of WBN Units 1 and 2 that are unchanged from the limits set for Unit 1 operation. **Undisputed.**

27. For Outfall 101, the discharge point for blowdown water from the CCW system, the NPDES permit for operation of WBN Units 1 and 2 allows discharge only when the release from Watts Bar Dam is at least 3500 cfs, and specifies a discharge temperature limit of 35°C.

These requirements are unchanged from those set in TVA's NPDES permit for operation of Unit 1 alone. **Undisputed.**

28. For Outfall 102, the discharge point for the CCW holding ponds, the NPDES permit for dual unit operation allows discharge only under emergency situations. Even then, the NPDES permit limits the temperature of discharged water to 35°C and requires that TVA make every effort to use this outfall only when the flow of the receiving waters meets or exceeds 3500 cfs. This condition is unchanged from that in the NPDES permit for WBN Unit 1. **Undisputed.**

29. For Outfall 113, the discharge point for the SCCW system, the NPDES permit for operation of Units 1 and 2 specifies a discharge temperature limit based on the receiving water. For example, the NPDES permit requires that the temperature rise at the edge of the mixing zone shall not exceed 3°C relative to an upstream control point. The limits that apply to Outfall 113 in the current NPDES permit are unchanged from those established in the NPDES permit for WBN Unit 1 operation. **Undisputed.**

30. Because the thermal discharge limits established by TVA's NPDES permit for dual unit operation are unchanged from those for Unit 1 operation, thermal impacts on the aquatic environment resulting from WBN operation will not be materially different under dual unit operation than they are for operation of Unit 1 alone. **Disputed. There will be substantial increases in discharge from the CCW and SCCW. See Table 3-1 of the DFES, at page 3-9:**

	WB1&WB2	WB1
Blowdown rate when diffusers are discharging from cooling towers and YHP IPS makeup flow	4.81 m ³ /s (170 cfs) ^(b)	3.82 m ³ /s (135 cfs) ^(b)
SCCW		
Intake flow rate	7.1 m ³ /s (250 cfs)	7.31 m ³ /s (258 cfs)
Discharge flow rate	8.46 m ³ /s (299 cfs)	7.48 m ³ /s (264 cfs)

Also, as discussed in Dr. Young's Declaration at pars. III-C.1-11, the already-stressed Tennessee River aquatic environment will be further stressed by additional CCW and SCCW thermal discharge from cumulative cooling tower blowdown discharge to the Tennessee River as a result of WB2 operation.

II. Description of TVA's Aquatics Studies

31. As noted in ¶ 10 above, TVA conducted a number of aquatics studies in direct response to the assertions made by SACE and its expert, Dr. Young, in Contention 7. Those studies, which are described in more detail below, collectively provide data on fish and mussel populations in the WBN vicinity, and the entrainment, impingement, and hydrothermal impacts on those species that result from operation of WBN Unit 1. In addition, TVA conducted some of the studies to resolve alleged errors in TVA's original studies identified by SACE and Dr. Young. **Undisputed that TVA conducted the studies described in pars. (A) through (G) below. Disputed that the studies resolve Dr. Young's concerns, as discussed throughout his Declaration.**

A. Comparison of Fish Species Occurrence and Trends in Reservoir Fish Assemblage Index Results in Chickamauga Reservoir Before and After WBN Unit 1 Operation (June 2010) ("RFAI Study")

32. In Contention 7, SACE and Dr. Young claimed that TVA relies on poor and outdated data about the health of the aquatic community in the WBN vicinity in lieu of recent monitoring studies. Dr. Young challenged TVA's characterization of the health of the fish community in the WBN vicinity, which TVA based in part on measured RFAI data. In response to those allegations, TVA conducted this new study to explain RFAI methodology and evaluate the aquatic community in the WBN vicinity using that methodology. **Undisputed.**

33. First, this study provides a detailed explanation of TVA's RFAI methodology. TVA created the RFAI methodology based on industry standards for biological indices, including those approved by TDEC and the U.S. Environmental Protection Agency ("EPA"), for use in its Vital Signs monitoring program. TVA has conducted fish sampling in the Chickamauga Reservoir every year since 1993, in support of this program. **Undisputed as to the conduct of the RFAI study every year since 1993. Disputed as to the consistency, accuracy, and usefulness of the study to portray aquatic health in the Tennessee River near WBN1. See Young Declaration, ¶¶ III-E.1-20.**

34. RFAI methodology uses twelve fish community metrics from four general categories: Species Richness and Composition; Trophic Composition; Abundance; and Fish Health. For each metric, scores are given on a scale from 1 to 5, with a score of 5 indicating optimum health. The resulting scores range from 12-60, broken down as follows: 12-21 ("Very Poor"), 22-31 ("Poor"), 32-40 ("Fair"), 41-50 ("Good"), or 51-60 ("Excellent"). RFAI scores have an intrinsic variability of ± 3 points. **Undisputed as to the description of the RFAI methodology. Disputed as to the consistency, accuracy, and usefulness of the RFAI methodology to portray aquatic health in the Tennessee River near WBN1. See Young Declaration, ¶¶ III-E.3-17.**

35. RFAI methodology addresses all five attributes or characteristics of a Balanced Indigenous Population ("BIP"), which is required by the Clean Water Act. If an RFAI score reaches 70% of the highest attainable score of 60 (i.e., 42), or if fewer than half of the RFAI metrics receive a low (1) or moderate (3) score, then normal community structure and function are considered to be present, indicating that BIP is maintained. **Undisputed that this is a description of TVA's methodology for compliance with the BIP requirement. Disputed as to the fact that RFAI methodology only addresses four not five attributes, and to the consistency, accuracy, and usefulness of this methodology to portray aquatic health in the Tennessee River near WBN1. See Young Declaration, ¶¶ III-E.1-20.**

36. Second, this study evaluates the health of the aquatic environment in the WBN vicinity based on recent fish surveys and the RFAI methodology. The study found that RFAI scores from the site downstream of the WBN intake and thermal discharge have averaged 44 from 1996 to 2008 (i.e., during operation of WBN Unit 1), indicating that the aquatic health of that area is "good" even during WBN operation. **Undisputed that this is a description of TVA's RFAI study, results, and conclusions. Disputed as to the consistency, accuracy, and usefulness of this methodology to portray aquatic health in the Tennessee River near**

WBN1 and the concluding scores to properly correlate with the true health of the fish community. See Young Declaration, ¶¶ III-E.1-20.

37. Third, this study compares the health of that environment as reflected in RFAI scores from before and after WBN operation. Scores from every sample year (1993-2008) were at least 42, i.e., 70% of the highest attainable score of 60. As a result, the study concluded that both before and after WBN operation, BIP has been maintained. **Undisputed that this is a description TVA's RFAI study, results, and conclusions. Disputed as to the consistency, accuracy, and usefulness of this methodology to portray aquatic health in the Tennessee River near WBN1. See Young Declaration, ¶¶ III-E.1-20.**

38. SACE has not challenged the methodology or findings of this study with this Board. **Undisputed that SACE has not challenged the most recent iteration of the RFAI study before the Board. Contention 7, however, criticizes the methodology and results of previous RFAI studies, which have not changed in any significant respect. See Young Declaration, ¶ E-III.1.**

B. Analysis of Fish Species Occurrences in Chickamauga Reservoir – A Comparison of Historic and Recent Data (Oct. 2010) (“Fish Species Occurrences Study”)

39. SACE claimed in Contention 7 that TVA relies on inadequate and outdated data to form its conclusion that fish populations in the WBN vicinity are in good health, and has not taken steps necessary to evaluate how effluent from WBN may affect fish communities. In direct response, TVA conducted this study to analyze extensive historic and recent fish survey data from the WBN vicinity, and compare the current prevalence of fish species to historic (i.e., pre-operational) values. **Undisputed except with respect to TVA's characterization of the data as “extensive.” As discussed in Dr. Young's Declaration at pars III-E.2-3, there are significant inadequacies in the analyses found in this report.**

40. This study uses the extensive fish survey data available for the WBN vicinity, dating back to 1947. Because it also provides recent survey data for the fish populations in the WBN vicinity, this study inherently reflects the impact of the current operation of WBN Unit 1 on those populations. **Undisputed to the extent that TVA states it used fish survey data back to 1947 and provides recent survey data. Disputed with respect to TVA's characterization of the data as “extensive” and TVA's conclusion that this study alone inherently reflects the impact of the current operation of WBN1 on fish populations. See Dr. Young's Declaration throughout.**

41. In analyzing the collective historical fish survey data for the Chickamauga Reservoir, this study takes into consideration the variations in survey methods employed over the past 60 years. Variations in survey methodology preclude direct comparisons between historical and recent surveys. This study also compared the results of fish sampling efforts in various Tennessee River reservoirs subject to similar conditions to understand widespread patterns and behavior of species in reservoir environments. **Disputed. While the study may acknowledge the variations in survey methods employed over the years, it does not cure the mistakes of the past, and instead perpetuates them. TVA either has an “extensive” fish species survey/study for historical comparison, which shows significant decline of fish species overtime, including since operation of Unit 1, or TVA has an unreliable, outdated, and**

inadequate means to properly evaluate impacts from WBN. The different sampling methods do not detract from the fact that there has been a decline in fish species pre- and post-WBN operation, which is evidence that the health of the fish community is poor *See* Dr. Young's Declaration at pars. III-E.1-20.

42. This study found that species occurrence and abundance in the Chickamauga Reservoir has changed from 1947 to 2009. Many of these changes took place before operation of WBN Unit 1 began. **Undisputed to the extent that TVA asserts that many of the changes in species occurrence and abundance in the Chickamauga Reservoir took place before the operation of WBN1 began. Disputed to the extent that TVA implies that changes after WBN1 operation began are insignificant. *See* Young Declaration, ¶¶ III-E.1-20.**

43. One major cause of this change is impoundment of the Tennessee River, which began in the 1930s and has altered habitats required for various life stages of aquatic species. Some of the species not found in recent surveys require unimpounded, free flowing riverine environments. **Undisputed to the extent that impoundment of the Tennessee River is a major cause of the decline in species occurrence and abundance. Disputed to the extent that TVA implies that changes after WBN1 operation began are insignificant. *See* Young Declaration, ¶¶ III-E.1-20 and III-D.4-7, III-D.10, and III-A.6-9.**

44. The study found that another reason for the change in species diversity and abundance is that most species that have not been collected in recent times have historically never been caught frequently or in large numbers in Chickamauga Reservoir. **Undisputed that this is a conclusion of the study. Disputed as a rationale for the decline of indigenous species present and decline of indigenous species abundance. The fact that species have not been caught in the reservoir is a meaningful indication of the decline of indigenous fish species. *See* Young Declaration, ¶¶ III-E.1-20.**

45. Finally, the study found that changes in fish survey methods account for some of the changes in findings of species occurrence and abundance. Certain survey methods, such as hoop nets, trap nets, and cove rotenone sampling, that were effective for targeting certain species, are no longer in use. **Undisputed in that this is a conclusion of the study. Disputed as being used as rationale for the decline of the fish community. Even with TVA's many changes in methods, a clear pattern of declining indigenous fish species and their abundance pre- and post-WBN operation is clear. *See* Young Declaration, ¶¶ III-E.1-20 and III-D.4-7, III-D.10, and III-A.6-9.**

46. As a result, this study concluded that there is no basis to support a finding that operation of WBN Unit 1 caused the observed changes in fish species and occurrence in the Chickamauga Reservoir. **Undisputed as to the study's stated conclusion. Disputed as to whether the conclusion is accurate that there is no basis to support a finding that operation of WBN1 caused the observed changes in fish species and occurrence. *See* Young Declaration, ¶¶ III-A.1-14, III-B.1-5, III-C.1-12, and III-E.1-20.**

47. SACE has not challenged the methodology or findings of this study with this Board. **Undisputed.**

C. Mollusk Survey of the Tennessee River Near [WBN] (Rhea County, Tennessee) (Oct. 28, 2010, Revised Nov. 24, 2010) ("Mollusk Survey"), and Discussion of the Results of the 2010 Mollusk Survey of the Tennessee River Near [WBN] (Rhea County, Tennessee) (Mar. 2011) ("Discussion of Mollusk Survey")

48. In Contention 7, SACE claimed that TVA relies on inadequate and outdated data to estimate the effects of WBN operation on mussels in the WBN vicinity. In support, Dr. Young alleged that the mussel community in the WBN vicinity is not in good health, and that TVA has not given sufficient consideration of the impact of WBN operation on that community. **Undisputed.**

49. To remedy those alleged deficiencies, TVA engaged an outside consultant to conduct a survey of the mussel community in the WBN vicinity in 2010. The consultant conducted semi-quantitative and quantitative mollusk sampling in three sample areas at which TVA has previously conducted pre-operational and operational mollusk surveys. **Undisputed.**

50. Because WBN Unit 1 was in operation in 2010 and had been in operation for more than a decade, this survey inherently reflects the impact of the operation of WBN Unit 1 on the mussel community in the WBN vicinity. **Disputed as to a one year survey capturing the population trend of a mussel community. It was reasonable for TVA to have contracted for a multi-year study when it was decided to apply for the operating license.**

51. The consultant provided the results in the Mollusk Survey. TVA subsequently produced Discussion of Mollusk Survey, analyzing the results of the Mollusk Survey and comparing those results to preoperational (1983 to 1994) and operational (1996 to 1997) monitoring of the mollusk communities at WBN. **Undisputed.**

52. These studies agree that the Chickamauga Reservoir in the WBN vicinity is not the ideal habitat for mussels. Still, the 2010 survey found that the mussel community in the WBN vicinity is in substantially similar condition as it was near the end of the previous operational monitoring period (1996 to 1997), in both species composition and the number of mussels collected. In addition, the 2010 survey collected juveniles of at least five mussel species, evidencing reproduction of mollusks in the WBN vicinity. **Undisputed as to the agreement a reservoir may not be ideal habitat for mussels. Disputed as to what results the consultant produced versus what conclusions TVA drew from that data. Disputed as to the mussel community in the WBN vicinity being in substantially similar condition as it was near the end of the previous operational monitoring period and the significance of the collection of five juvenile mussel species. See Young Declaration, ¶¶ III-D.1-7.**

53. As a result, this study concluded that there is no basis to support a finding that the relatively low densities of mussels in the WBN vicinity are the result of operation of WBN Unit 1. **Undisputed that this is the conclusion stated. Disputed as to the accuracy and reasonableness of the conclusion. See Young Declaration, ¶ III-D.4-7.**

54. SACE has not challenged the methodology or findings of this study with this Board. **Undisputed.**

D. Aquatic Environmental Conditions in the Vicinity of Watts Bar Nuclear Plant During Two Years of Operation, 1996-1997 (June 1998, Revised June 2010) (“Revised Aquatics Study”)

55. TVA completed the initial Aquatics Study in 1998, comparing pre-operational (1973 to 1979, 1982 to 1985) and operational (1996 to 1997) aquatic monitoring in the WBN vicinity. The original study focused on the effects of WBN operation on fish (juveniles and adults), benthic macroinvertebrates, and water quality. As part of the analysis of the effects on fish, the study estimated entrainment of ichthyoplankton and impingement of fish resulting from operation of WBN Unit 1. **Undisputed.**

56. The original study concluded that ichthyoplankton were present in relatively low densities in the vicinity of the WBN intake, and that those that were present had passed through the turbines of the Watts Bar Dam. The study also found that most spawning that occurs in Chickamauga Reservoir occurs downstream of the WBN intake. In other words, relatively few ichthyoplankton were available to be entrained at the WBN intake. The original study concluded that the percent of ichthyoplankton entrained was very low, and that WBN entrainment has no impact on the fish populations in the WBN vicinity. **Undisputed with respect to TVA’s description of the study. Disputed in Contention 7. Disputed as to accuracy of results and conclusions. See Young Declaration, ¶ III-A.2 and III-A.12.**

57. TVA revised this study in direct response to concerns raised by SACE in Contention 7, and by Dr. Young in support of Contention 7, that TVA’s methods for estimating entrainment were flawed. Dr. Young claimed that TVA erroneously assumed that distribution of ichthyoplankton across the reservoir is uniform, and did not take into account variations in seasonal abundance of ichthyoplankton. Dr. Young also alleged that TVA should estimate entrainment using actual intake water demand and river flow values. **Undisputed as to stated information. Disputed as to the Aquatics Study was also revised after Dr. Young identified major clerical and mathematical errors that had gone unnoticed for over a decade.**

58. In response to Dr. Young’s concerns, TVA revised the entrainment analysis to account for seasonality of ichthyoplankton occurrence and reservoir releases from Watts Bar Dam. TVA also used actual intake water demand and reservoir flow values. **Undisputed that TVA revised its entrainment analysis to account for seasonality of ichthyoplankton occurrence and reservoir releases and that TVA used actual intake water demand and reservoir flow values. Disputed as to whether TVA did, in fact, account for seasonality of ichthyoplankton occurrence prior to the Peak Entrainment Study in 2010. See Young Declaration, ¶ III-A.2.**

59. After conducting the revised entrainment estimates, TVA found that its overall conclusions regarding entrainment were unchanged. Estimated entrainment rates remained very low. For samples collected in 1996, percent entrainment in the revised analysis was estimated to be 0.29% for fish eggs and 0.57% for fish larvae. For samples collected in 1997, percent entrainment in the revised analysis was estimated to be 0.02% for fish eggs and 0.22% for fish larvae. **Undisputed that TVA has describe the results of the study. Disputed is the accuracy and validity of these results. See Young Declaration, ¶ III-A.2.**

60. TVA's experts concluded that these rates are "low" and therefore there is no impact to the ichthyoplankton populations of Chickamauga Reservoir as a result of operation of WBN Unit 1. **Undisputed as to the description of the conclusion by TVA's experts. Disputed as to the reasonableness of the conclusion. The data were not sufficient to support the conclusion as this study was only for a 3-month period during only 2 years, one of which Unit 1 was not even operational or only at partial-capacity for a majority of time. The Revised Aquatics Study has the same shortcomings and still arrives at the same conclusions that are disputed in Contention 7. See Young Declaration, ¶¶ III-A.2 and III-A.12.**

61. SACE has not challenged the methodology or findings of this study with this Board. **Undisputed.**

E. Comparison of 2010 Peak Spawning Seasonal Densities of Ichthyoplankton at [WBN] at Tennessee River Mile 528 with Historical Densities During 1996 and 1997 (Apr. 2011, Revised Nov. 2011) ("Peak Spawning Entrainment Study")

62. TVA conducted this study to respond to SACE and Dr. Young's concerns that TVA's methods for estimating entrainment were flawed, and that TVA should have taken direct measurements of entrainment. **Undisputed.** TVA collected raw data on actual entrainment at WBN during Unit 1 operation from March 2010 through March 2011, to ensure that all of SACE and Dr. Young's concerns regarding entrainment estimates were addressed, and in direct response to requests from SACE and Dr. Young for recent actual entrainment monitoring at WBN during operation of WBN Unit 1. **Undisputed with respect to the assertion that TVA collected raw data on actual entrainment at WBN1 in 2010-11. Disputed as to whether the data collected were sufficient to resolve Dr. Young's concerns. See Young Declaration, ¶¶ III-A.4.**

63. This study reports entrainment resulting from operation of WBN Unit 1, as measured during the peak spawning period of April through June, 2010. TVA used this timeframe to address SACE and Dr. Young's concern that TVA account for the spawning patterns of fish species in the Chickamauga Reservoir and the high abundance of ichthyoplankton during certain times of year. **Disputed with respect to the assertion that the study reports entrainment from operation of WBN1 as measured through the peak spawning period in 2010. This study only reports entrainment at the CCW, and does not report entrainment by the SCCW. Thus, the cumulative entrainment due to operation of WBN Unit1 is not known. Disputed with respect to whether the data collected were sufficient to resolve Dr. Young's concerns. See Young Declaration, ¶¶ III-A.5.**

64. This study concluded that measured entrainment rates at the WBN in 2010 were below one half of one percent of the ichthyoplankton population in the WBN vicinity, and consistent with those calculated for the same period during the first two years of operation of Unit 1, 1996 to 1997, when consistent calculation methods were applied. Specifically, the study found that the percent of entrained eggs in 2010 (0.12%) was within the range for 1996 (0.2%) and 1997 (0.2%). Likewise, the study found that the percent of entrained larvae in 2010 (0.40%) was within the range for 1996 (0.88%) and 1997 (0.22%). **Undisputed that TVA correctly describes the study's results. Disputed with respect to the accuracy of the results. See Young Declaration, ¶¶ III-A.2, III-A.5, and III-A.10-11.**

65. TVA's experts concluded that these entrainment rates are "very low," and are not adversely affecting the fish population in the WBN vicinity. **Undisputed that this is the conclusion by TVA's experts. Disputed as to the accuracy and reasonableness of the conclusion. See Young Declaration, ¶ III-A.1-12.**

66. The increased water intake demand for the CCW caused by dual unit operation will result in an estimated increase in hydraulic entrainment of approximately 0.2%. This study found that ichthyoplankton entrainment will increase proportionately with hydraulic entrainment. This increase will result in entrainment percentages that are still less than 1% of the ichthyoplankton population. This study concluded that, as a result, dual unit operation will not result in a material change in entrainment impacts. **Disputed as to the accuracy and reasonableness of this conclusion, and the rationale/methodology to arrive at this conclusion. See Young Declaration, ¶ III-A.13-14.**

67. SACE has not challenged the methodology or findings of this study with this Board. **Undisputed.**

F. Fish Impingement at [WBN] Intake Pumping Station Cooling Water Intake Structure During March 2010 through March 2011 (Mar. 2011, Revised Apr. 2011) ("Impingement Study")

68. This study analyzes raw impingement data collected at the CCW intake during operation of WBN Unit 1 from March 2010 through March 2011. **Undisputed.** TVA used this data, in combination with the existing recent SCCW impingement data, to estimate the annual impingement mortality of fish in the vicinity of WBN as the result of operation of WBN Unit 1, and to predict the impact from operation of Unit 2. **Disputed as to the fact that TVA did not update the SCCW impingement in conjunction with the CCW impingement in this study.** TVA conducted this study in response to allegations by SACE and Dr. Young that TVA's analysis of the effects of WBN operation on the aquatic community was deficient because TVA had not conducted recent studies of actual impingement at the CCW intake. **Undisputed with respect to the assertion that TVA conducted the study. Disputed as to whether the study was sufficient to resolve Dr. Young's concerns. See Young Declaration, ¶ III-B.1-5.**

69. This study found that total impingement values in 1996 to 1997 (161) were less than those measured in 2010 to 2011 (13,573). This study also found, however, that mortality resulting from a cold shock event dominated impingement mortality at WBN in 2010 to 2011. Shad in the Southeastern United States, including the Chickamauga Reservoir, are susceptible to cold shock. When temperatures fall below 50°F, they become lethargic and more susceptible to impingement. The study found that the most significant impingement events observed at WBN in 2010 to 2011 were the result of cold shock. **Undisputed as to the accuracy of TVA's description of the study's conclusions. Disputed as to the implication that cold shock, not the operation of WBN1, is the most significant cause of impingement mortality. See Young Declaration, ¶ III-B.1-4.**

70. Excluding the cold shock event, this study found that fewer fish and number of species were impinged in 2010 to 2011, than in 1996 to 1997. The EPA endorses an impingement modeling approach that excludes the effects of extreme environmental conditions.

The EPA also acknowledges the effects of cold shocks on shad. **Disputed as to the cause of mortality. The mortality was caused by impingement against a man-made structure due to intake flow velocities not just the physiological consequences of cold temperatures. See Young Declaration, ¶ III-B.1-4.**

71. This study concludes that low numbers of impinged fish in both 1996-97 and 2010-11 indicate that impingement resulting from operation of WBN Unit 1 will not materially affect fish populations in the WBN vicinity. **Disputed as to the reasonableness of the study duration being adequate to determine this conclusion, and as to the reasonableness of the conclusion. See Young Declaration, ¶ III-B.1-5.**

72. Dual unit operation will result in increased withdrawal of water through the CCW intake channel. Impingement will likewise increase at a rate that is proportional to the increase in flow rate. This study concluded that the impingement increase from dual unit operation would still be very small when compared to the effects of cold shock and winter kills on shad. As a result, TVA's experts concluded that operation of Unit 2 will not result in material increases in impingement at WBN. **Disputed as to this methodology that was also used similarly by TVA to arrive at conclusions of entrainment from the combined operation of Unit 1 and 2. See Young Declaration, ¶ III-A.13-14.**

73. SACE has not challenged the methodology or findings of this study with this Board. **Undisputed.**

G. Hydrothermal Effects of the Ichthyoplankton from the Watts Bar Nuclear Plant Supplemental Condenser Cooling Water Outfall in Upper Chickamauga Reservoir (Jan. 2011) ("Hydrothermal Study")

74. This study analyzes the hydrothermal impacts of WBN operation, based on in-river testing in the vicinity of the WBN outfall during WBN operation in May and August, 2010. TVA conducted this study in direct response to claims by SACE and Dr. Young that TVA should study the hydrothermal effects of operation of WBN Unit 1 on the aquatic environment in the WBN vicinity. Dr. Young alleged that TVA does not provide data on spatial or temporal distribution of ichthyoplankton in relation to thermal mixing zones, does not evaluate the impact of discharge temperatures on ichthyoplankton, and does not account for impacts of variations in the size or temperature profile of the mixing zone. **Undisputed**

75. In direct response to these claims, TVA designed this study to document the flow patterns and characteristics of the thermal plume from WBN, and track the thermal plume in conjunction with ichthyoplankton sampling. This allowed TVA to understand the temporal and spatial distribution of ichthyoplankton and exposure rates to thermal discharges. **Disputed as to the fact that TVA failed to study the thermal discharge from Outfall 101 in conjunction with Outfall 113 to encompass the cumulative thermal discharge from WBN, and failed to address exposure rates and the effects of abrupt temperature changes on ichthyoplankton in this study. See Young Declaration, ¶ III-C.3-4.**

76. TVA conducted this study in May and August, 2010, because those time frames represented extreme conditions: peak abundance of fish eggs and larvae, near maximum ambient water temperatures, and no release from the upstream Watts Bar Dam. **Undisputed as to**

timeframe of study. **Disputed as to whether this would be representative over time as this study only represents a few points in time, not adequately addressing environmental variability. See Young Declaration, ¶ III-C.2.**

77. This study found that, even under these extreme conditions, water temperatures did not approach the limits established by TVA's NPDES permit for operation of WBN Units 1 and 2. **Disputed as study results directly stated to the contrary. See Young Declaration, ¶ III-C.11.** Because discharge temperatures did not exceed those set in TVA's NPDES permit, this study concluded that there was no risk of thermal damage to ichthyoplankton from operation of WBN. **Disputed as to accuracy and reasonableness of these conclusions. See Young Declaration, ¶ III-C.1-11.**

78. Even if operation of WBN Units 1 and 2 causes effluent temperatures to rise above those measured even under extreme conditions for Unit 1, TVA is bound by its NPDES discharge limits. Accordingly, dual unit operation does not pose any greater risk of thermal damage to the aquatic community in the WBN vicinity than does operation of Unit 1 alone. **Disputed as to accuracy and reasonableness of these conclusions. See Young Declaration, ¶ III-C.1-11.**

79. SACE has not challenged the methodology or findings of this study with this Board. **Undisputed.**

IV. Overview of the Draft SFES Conclusions Regarding TVA's Aquatic Studies

80. As noted previously, the NRC Staff's Draft SFES concurs with the findings presented in TVA's aquatics studies. **Undisputed.**

81. Specifically, the Staff concurred with TVA's findings regarding entrainment impacts, concluding in the Draft SFES that hydraulic entrainment would have a very minor impact on the aquatic biota in the vicinity of WBN. The Staff agrees that existing levels of measured entrainment under Unit 1 operation are too low to be readily detected in the aquatic populations in the WBN vicinity, and the additional water withdrawn via the CCW intake will not be noticeable or furthermore destabilizing to the aquatic ecology in the WBN vicinity. Moreover, the Staff concludes that the water withdrawn from the SCCW intake will actually decrease under dual unit operation. In drawing these conclusions, the Staff relies in part on the Revised Aquatics Study and the Peak Spawning Entrainment Study. **Undisputed. It should be noted that the NRC Staff has not conducted any independent studies to support its conclusions.**

82. The Staff's conclusions regarding impingement impacts are similar. The Staff finds that measured levels of impingement under operation of WBN Unit 1 are low and impingement effects are too minor to be readily detected in aquatic populations in the WBN vicinity. The increased flow rates for the CCW intake under dual unit operation will not alter that conclusion, concludes the Staff, and the decreased flow rates for the SCCW intake will not increase impingement effects. The Staff relied in part on the Impingement Study in drawing these conclusions. **Undisputed. It should be noted that the NRC Staff has not conducted any independent studies to support its conclusions.**

83. With respect to thermal impacts from operation of WBN Unit 2, the Staff concludes that this effect also will be undetectable and will not destabilize or noticeably alter the aquatic biota in the WBN vicinity. The Staff based this conclusion in part on the Hydrothermal Study, as well as limits set by the NPDES permit. **Undisputed. It should be noted that the NRC Staff has not conducted any independent studies to support its conclusions.**

84. The Staff concludes in the Draft SFES that although the impoundments and industrial facilities have a significant cumulative impact on the aquatic biota in the WBN vicinity, "the overall impacts on aquatic biota, including Federally listed threatened and endangered species, from impingement and entrainment at the SCCW and IPS [i.e., CCW] intakes and from thermal . . . discharges as a result of operating Unit 2 on the WBN site are SMALL." **Undisputed. It should be noted that the NRC Staff has not conducted any independent studies to support its conclusions.**

Respectfully submitted,

Electronically signed by

Diane Curran

HARMON, CURRAN, SPIELBERG, & EISENBERG, L.L.P.

1726 M Street N.W., Suite 600

Washington, D.C. 20036

202-328-3500

Fax: 202-328-6918

e-mail: dcurran@harmoncurran.com

December 20, 2011

December 20, 2011

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of)

Tennessee Valley Authority)

(Watts Bar Unit 2))

Docket No. 50-391-OL

**SOUTHERN ALLIANCE FOR CLEAN ENERGY'S
STATEMENT OF DISPUTED MATERIAL FACTS**

Southern Alliance for Clean Energy ("SACE") respectfully submits the following statement of disputed material facts in response to Tennessee Valley Authority's ("TVA's") Statement of Material Facts on Which No Genuine Issue Exists (Nov. 21, 2011). SACE responds as follows:

I. Procedural Background

A. Licensing History for Watts Bar Nuclear Plant

1. On May 14, 1971, TVA applied for a Construction Permit ("CP") for the Watts Bar Nuclear Plant ("WBN"). The NRC issued CPs for WBN Units 1 and 2 on January 23, 1973, and construction began. TVA substantially completed construction of Unit 1 in 1985. **Undisputed.**

2. On June 30, 1976, TVA first filed an application for an operating license ("OL") for WBN Units 1 and 2. On February 7, 1996, the NRC issued an OL for Unit 1 that authorized operation at 100% power. **Undisputed.**

3. Between 1973 and 2008, the NRC extended the CP for Unit 2 on several occasions. During this time, TVA maintained WBN Unit 2 in deferred plant status, in accordance with the NRC's "Policy Statement on Deferred Plants." **Undisputed.**

4. On August 3, 2007, TVA informed the NRC Staff its intention to resume and complete construction of WBN Unit 2. TVA updated its original OL application for WBN Unit 2 on March 4, 2009, prompting the NRC to publish a notice of hearing in the Federal Register on May 1, 2009. **Undisputed.**

5. Throughout this time, TVA and the NRC completed a number of environmental reviews of WBN. On November 9, 1972, TVA issued a Final Environmental Statement for WBN Units 1 and 2 ("TVA 1972 FES"). On December 1, 1978, the NRC issued its Final Environmental Statement evaluating the operation of Units 1 and 2 ("NRC 1978 FES"). The NRC supplemented its 1978 FES on April 1, 1995 ("NRC 1995b"), in order to re-examine environmental considerations before issuing an OL for WBN Unit 1. **Undisputed.**

6. When TVA reactivated construction of WBN Unit 2, it also submitted its Final Supplemental Environmental Impact Statement ("2007 FSEIS") to the NRC on February 15, 2008. The NRC published its draft supplement to the final environmental statement ("Draft SFES") on October 31, 2011. **Undisputed.**

B. Intervention in Current Proceeding

7. After TVA updated its OL application for WBN Unit 2 and the NRC issued a Notice of Opportunity for Hearing on May 1, 2009, five organizations (Southern Alliance for Clean Energy ("SACE"), Tennessee Environmental Council, We the People, the Sierra Club, and Blue Ridge Environmental Defense League) jointly filed a Petition to Intervene and Request for Hearing, which included seven contentions. Among those, Contention 7 challenged TVA's analysis of the impact of operation of WBN Unit 2 on the aquatic environment. In Contention 7, SACE alleged:

TVA claims that the cumulative impacts of WBN Unit 2 on aquatic ecology will be insignificant (FSEIS Table S-1 at page. S2, and Table 2-1 at page. 30). [sic] TVA's conclusion is not reasonable or adequately supported, and therefore 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 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. **Undisputed.**

8. The NRC Staff and TVA subsequently filed answers addressing the Petition. On September 3, 2009, SACE filed a Motion for Leave to Amend Contention 7, along with an Amended Contention 7. Both TVA and the NRC Staff filed responses opposing SACE's Motion and Answers to the Amended Contention. SACE thereafter filed a reply to the Answers to the Amended Contention on October 5, 2009. **Undisputed.**

9. On November 19, 2009, this Board granted the Petition to Intervene on behalf of SACE, admitting two contentions. The Board denied SACE's Motion to Amend Contention 7, instead admitting Contention 7 as originally presented. Although the Board admitted Contention 1 along with Contention 7, TVA moved to dismiss Contention 1 as moot on April 19, 2010. The Intervenor did not oppose that motion, and the Board granted TVA's unopposed Motion and dismissed Contention 1 accordingly. As a result, only Contention 7 remains to be resolved. **Undisputed.**

C. New Information on the Record – TVA's Aquatic Studies and NRC's Draft SFES

10. In direct response to the issues raised by SACE in Contention 7, TVA collected extensive new data on the current health of the aquatic environment and the impact of operation

of WBN Unit 1 on that environment, prepared numerous updated and expanded aquatics-related analyses, documented the analyses in published reports and studies, and disclosed these reports and studies to the NRC Staff and SACE. **Undisputed except with respect to TVA's characterization of the data as "extensive." As discussed throughout Dr. Young's Declaration, there are significant gaps and inadequacies in the data.**

A complete list of those studies, including the dates that TVA disclosed each to SACE and the NRC Staff, follows:

- a. Comparison of Fish Species Occurrence and Trends in Reservoir Fish Assemblage Index Results in Chickamauga Reservoir Before and After [WBN] Unit 1 Operation (June 2010) ("RFAI Study"), which TVA disclosed to SACE and the NRC Staff on July 15, 2010;
 - b. Analysis of Fish Species Occurrences in Chickamauga Reservoir – A Comparison of Historic and Recent Data (Oct. 2010) ("Fish Species Order (Granting TVA's Unopposed Motion to Dismiss SACE Contention 1) (June 2, 2010) (unpublished). Occurrences Study"), which TVA disclosed to SACE and the NRC Staff on November 15, 2010;
 - c. Mollusk Survey of the Tennessee River Near [WBN] (Rhea County, Tennessee) (Nov. 2010) ("Mollusk Survey"), which TVA disclosed to SACE and the NRC Staff on January 18, 2011;
 - d. Discussion of the Results of the 2010 Mollusk Survey of the Tennessee River Near [WBN] (Rhea County, Tennessee) (Mar. 2011) ("Discussion of Mollusk Survey"), which TVA disclosed to SACE and the NRC Staff on March 15, 2011;
 - e. Aquatic Environmental Conditions in the Vicinity of [WBN] During Two Years of Operation, 1996-1997 (June 1998, Revised June 2010) ("Revised Aquatics Study"), which TVA disclosed to SACE and the NRC Staff on July 15, 2010;
 - f. Comparison of 2010 Peak Spawning Seasonal Densities of Ichthyoplankton at [WBN] at Tennessee River Mile 528 with Historical Densities during 1996 and 1997 (Apr. 2011, Revised Nov. 2011) ("Peak Spawning Entrainment Study"), which TVA disclosed to SACE and the NRC Staff on April 15, 2011;
 - g. Fish Impingement at [WBN] Intake Pumping Station Cooling Water Intake Structure during March 2010 through March 2011 (Mar. 2011, Revised Apr. 2011) ("Impingement Study"), which TVA disclosed to SACE and the NRC Staff on May 16, 2011; and
 - h. Hydrothermal Effects on the Ichthyoplankton from the [WBN] Supplemental Condenser Cooling Water Outfall in Upper Chickamauga Reservoir (Jan. 2011) ("Hydrothermal Study"), which TVA disclosed to SACE and the NRC Staff on February 15, 2011. **Undisputed.**
11. SACE has not raised any concerns with respect to these studies with the NRC or this Board. **Undisputed.**
12. The NRC Staff's Draft SFES, dated October 31, 2011, concurs with TVA's findings in its aquatics studies. Section IV, below, discusses the specific conclusions drawn by the Staff that are relevant to TVA's aquatic studies. **Undisputed.**

II. Description of the Proposed Project

A. General Information

13. The WBN site is located in Rhea County, Tennessee, on the west bank of the Tennessee River, in the upper Chickamauga Reservoir at Tennessee River Mile ("TRM") 528. **Undisputed.**

14. The Tennessee River System is approximately 650 miles long and is comprised of riverine and lacustrine environments, created by numerous dams and locks on the system, most of which have been in place since the 1940s. Chickamauga Dam, completed in 1940 at TRM 471, impounds Chickamauga Reservoir downstream of WBN. Watts Bar Hydroelectric Dam impounds the Watts Bar Reservoir 1.9 miles upstream of WBN. **Undisputed.**

15. The Tennessee River is also host to numerous industrial facilities. For example, WBN is located approximately one mile downstream of the decommissioned Watts Bar Fossil Plant. **Undisputed.**

16. TVA is the licensee and operator of the existing WBN Unit 1, a Westinghouse pressurized water reactor that began full commercial operation on May 27, 1996. **Undisputed.**

17. WBN Unit 1 was originally designed to operate only in a closed cycle cooling mode via the Condenser Cooling Water ("CCW") system. After TVA began operation of Unit 1, it determined that a supplemental cooling system would increase the efficiency of the plant. Accordingly, TVA began to use a Supplemental Condenser Cooling Water ("SCCW") system in 1998. **Disputed as to the reason TVA began to use the SCCW. The original cooling system was under-designed and would have prevented WB1 from achieving rated power output on hot summer days. Some form of cooling tower enhancement or supplemental cooling was/is necessary for WB1 to achieve rated output on hot summer days (when the highest annual demand is experienced on the TVA system). This is supported by the NRC's Draft SFEIS at page 3-4, which states:**

Evaporation of cooling-water system water from the cooling-tower increases the concentration of dissolved solids in the cooling-water system. In most closed-cycle wet cooling systems, a portion of the cooling water is removed and replaced with makeup water from the source (for WBN, the Tennessee River) to limit the concentration of dissolved solids in the cooling system and in the discharge to the receiving water body.

Because the WBN cooling tower cannot remove the desired amount of heat from the circulating water during certain times of the year, TVA added the Supplemental Condenser Cooling Water (SCCW) system to the cooling system for the WBN reactors (TVA 1998). The SCCW draws water from behind Watts Bar Dam and delivers it, by gravity flow, to the cooling-tower basins to supplement cooling of WBN Unit 1. This cooling system would also be used for Unit 2. The temperature of this water is usually lower than the temperature of the water in the cooling-tower basin and, as a result, lowers the temperature of the water being used to cool the steam in the

condensers. Slightly less water enters the cooling-tower basins through the SCCW intake than leaves the cooling-tower basins and is discharged to the Tennessee River through the SCCW discharge structure (TVA, 2010). *Since the SCCW has been operating, elevated total dissolved solids in blowdown water have not been a concern because a large volume of water continually enters and leaves the cooling-tower basins (PNNL 2009).*

(emphasis added). Had TVA more robust cooling system in the first place, the SCCW would never have been considered necessary by TVA and TVA would not now be proposing to operate WBN2 with the SCCW.

18. The present proceeding pertains to the OL for WBN Unit 2. The added operation of WBN Unit 2 may result in minimal increased demands on that aquatic environment both for cooling water intake and cooling water discharge. **Disputed as to the term “minimal.”** As discussed in Dr. Young’s Declaration throughout, the already-stressed Tennessee River aquatic environment will be further stressed by additional CCW intake and discharge and increased SCCW discharge to accommodate the operation of both WB1 and WB2 cooling towers and the increased cumulative cooling tower blowdown discharge to the Tennessee River as a result of WB2 operation. The combined operation of two units will have substantial impacts on the Tennessee River.

B. WBN Cooling System Intake

19. WBN Unit 2 shares intake channels with Unit 1. Operation of Unit 1 withdraws cooling water from CCW and SCCW intake channels. Under dual unit operation, WBN will continue to draw cooling water from the CCW and SCCW intake channels. **Undisputed.**

20. The SCCW system is gravity driven. As a result, intake flow and velocity for the SCCW depends on the water level behind the Watts Bar Dam. **Undisputed.**

21. Flow through the CCW is driven by the IPS, rather than gravity. The IPS will draw more water at a higher flow rate under dual unit operation than for operation of Unit 1 alone. CCW maximum intake velocities will not increase under dual unit operation because the intake will draw water through additional openings. **Undisputed.**

22. Studies show that the hydraulic entrainment from dual unit operation will result in an additional entrained amount of 0.2% of the flow in the Chickamauga Reservoir. The resulting total hydraulic entrainment represents approximately 0.5% of the flow in the Chickamauga Reservoir. This increased hydraulic entrainment will result in a proportionate increase in entrainment of the ichthyoplankton present in the water column. **Disputed as to this calculation is only partly correct, and only accurate at a very specific river flow past WBN Plant.** As discussed in Dr. Young’s Declaration at par. III-A.13-14, the 0.2% hydraulic entrainment for WB1 is based upon TVA using a long term average river flow past WBN of 27,000 cfs. Using 3,500 cfs, which is the minimum amount of flow from Watts Bar Dam that permits TVA to discharge thermal and chemical effluent through Outfall 101, the hydraulic entrainment increases to 2.1% (10 times higher). Then, with the addition of Unit 2 almost doubling hydraulic entrainment, the hydraulic entrainment at a flow of 3,500 cfs further increases to approximately 4.0% (20 times higher). Also, only data collected by field studies

in combination with proper methods for calculation may accurately characterize ichthyoplankton entrainment under any level of hydraulic entrainment.

23. Studies show that CCW flow rates resulting from dual unit operation will average 134 cubic feet per second ("cfs") at summer pool levels and 113 cfs at winter pool levels, an increase from those rates observed under operation of Unit 1 alone: 73 cfs and 68 cfs, respectively. (The maximum intake velocities will not change under dual unit operation because of the additional IPS openings available to accommodate increased flow.) The increased flow rates in the CCW intake channel resulting from dual unit operation will result in a proportionate increase in the rates of fish impingement. **Disputed. It is important to note that TVA identifies the makeup flow through the IPS as 174 fps, double the withdrawal from the Tennessee River that would occur with only WBN1 online, and an increase in warm blowdown discharge to the Tennessee River from 135 cfs to 170 cfs, a 26 percent increase. These are substantial increases, independent of the role of the SCCW. See Table 3-1 of the DFES, at page 3-9:**

	WB1&WB2	WB1 only
Blowdown rate when diffusers are discharging from cooling towers and YHP	4.81 m ³ /s (170 cfs) ^(b)	3.82 m ³ /s (135 cfs) ^(b)
IPS makeup flow	4.93 m ³ /s (174 cfs) ^(c)	2.5 m ³ /s (88 cfs)
SCCW		
Intake flow rate	7.1 m ³ /s (250 cfs)	7.31 m ³ /s (258 cfs)
Discharge flow rate	8.46 m ³ /s (299 cfs)	7.48 m ³ /s (264 cfs)

The rates of fish impingement may exponentially increase. Similar to the issue of hydraulic versus ichthyoplankton entrainment, only field monitoring will accurately determine impingement rates. See Young Declaration, ¶¶ III-A.13-14.

C. WBN Cooling System Output

24. WBN Unit 2 shares cooling water discharge outfalls with Unit 1. **Undisputed.**

25. The thermal discharge from WBN operation is bound by thermal limits established by TVA's NPDES permit. The NPDES system establishes legally enforceable, aquatic health-based limits on hydrothermal discharges, in accordance with state and federal statutes. The Tennessee Water Pollution Control Division ("TDEC") issued a new NPDES permit for the operation of WBN Units 1 and 2 on June 30, 2011, most recently revised on August 31, 2011. **Undisputed, except for the facts that the existence of a legal limit does not ensure there will be no significant impacts to aquatic organisms and is not a guarantee that the operation will stay within the limit.**

26. TVA's NPDES permit sets discharge limits for each of the WBN outfall points under operation of WBN Units 1 and 2 that are unchanged from the limits set for Unit 1 operation. **Undisputed.**

27. For Outfall 101, the discharge point for blowdown water from the CCW system, the NPDES permit for operation of WBN Units 1 and 2 allows discharge only when the release from Watts Bar Dam is at least 3500 cfs, and specifies a discharge temperature limit of 35°C.

These requirements are unchanged from those set in TVA's NPDES permit for operation of Unit 1 alone. **Undisputed.**

28. For Outfall 102, the discharge point for the CCW holding ponds, the NPDES permit for dual unit operation allows discharge only under emergency situations. Even then, the NPDES permit limits the temperature of discharged water to 35°C and requires that TVA make every effort to use this outfall only when the flow of the receiving waters meets or exceeds 3500 cfs. This condition is unchanged from that in the NPDES permit for WBN Unit 1. **Undisputed.**

29. For Outfall 113, the discharge point for the SCCW system, the NPDES permit for operation of Units 1 and 2 specifies a discharge temperature limit based on the receiving water. For example, the NPDES permit requires that the temperature rise at the edge of the mixing zone shall not exceed 3°C relative to an upstream control point. The limits that apply to Outfall 113 in the current NPDES permit are unchanged from those established in the NPDES permit for WBN Unit 1 operation. **Undisputed.**

30. Because the thermal discharge limits established by TVA's NPDES permit for dual unit operation are unchanged from those for Unit 1 operation, thermal impacts on the aquatic environment resulting from WBN operation will not be materially different under dual unit operation than they are for operation of Unit 1 alone. **Disputed. There will be substantial increases in discharge from the CCW and SCCW. See Table 3-1 of the DFES, at page 3-9:**

	WB1&WB2	WB1
Blowdown rate when diffusers are discharging from cooling towers and YHP	4.81 m ³ /s (170 cfs) ^(b)	3.82 m ³ /s (135 cfs) ^(b)
IPS makeup flow	4.93 m ³ /s (174 cfs) ^(c)	2.5 m ³ /s (88 cfs)
SCCW		
Intake flow rate	7.1 m ³ /s (250 cfs)	7.31 m ³ /s (258 cfs)
Discharge flow rate	8.46 m ³ /s (299 cfs)	7.48 m ³ /s (264 cfs)

Also, as discussed in Dr. Young's Declaration at pars. III-C.1-11, the already-stressed Tennessee River aquatic environment will be further stressed by additional CCW and SCCW thermal discharge from cumulative cooling tower blowdown discharge to the Tennessee River as a result of WB2 operation.

II. Description of TVA's Aquatics Studies

31. As noted in ¶ 10 above, TVA conducted a number of aquatics studies in direct response to the assertions made by SACE and its expert, Dr. Young, in Contention 7. Those studies, which are described in more detail below, collectively provide data on fish and mussel populations in the WBN vicinity, and the entrainment, impingement, and hydrothermal impacts on those species that result from operation of WBN Unit 1. In addition, TVA conducted some of the studies to resolve alleged errors in TVA's original studies identified by SACE and Dr. Young. **Undisputed that TVA conducted the studies described in pars. (A) through (G) below. Disputed that the studies resolve Dr. Young's concerns, as discussed throughout his Declaration.**

A. Comparison of Fish Species Occurrence and Trends in Reservoir Fish Assemblage Index Results in Chickamauga Reservoir Before and After WBN Unit 1 Operation (June 2010) ("RFAI Study")

32. In Contention 7, SACE and Dr. Young claimed that TVA relies on poor and outdated data about the health of the aquatic community in the WBN vicinity in lieu of recent monitoring studies. Dr. Young challenged TVA's characterization of the health of the fish community in the WBN vicinity, which TVA based in part on measured RFAI data. In response to those allegations, TVA conducted this new study to explain RFAI methodology and evaluate the aquatic community in the WBN vicinity using that methodology. **Undisputed.**

33. First, this study provides a detailed explanation of TVA's RFAI methodology. TVA created the RFAI methodology based on industry standards for biological indices, including those approved by TDEC and the U.S. Environmental Protection Agency ("EPA"), for use in its Vital Signs monitoring program. TVA has conducted fish sampling in the Chickamauga Reservoir every year since 1993, in support of this program. **Undisputed as to the conduct of the RFAI study every year since 1993. Disputed as to the consistency, accuracy, and usefulness of the study to portray aquatic health in the Tennessee River near WBN1. See Young Declaration, ¶¶ III-E.1-20.**

34. RFAI methodology uses twelve fish community metrics from four general categories: Species Richness and Composition; Trophic Composition; Abundance; and Fish Health. For each metric, scores are given on a scale from 1 to 5, with a score of 5 indicating optimum health. The resulting scores range from 12-60, broken down as follows: 12-21 ("Very Poor"), 22-31 ("Poor"), 32-40 ("Fair"), 41-50 ("Good"), or 51-60 ("Excellent"). RFAI scores have an intrinsic variability of ± 3 points. **Undisputed as to the description of the RFAI methodology. Disputed as to the consistency, accuracy, and usefulness of the RFAI methodology to portray aquatic health in the Tennessee River near WBN1. See Young Declaration, ¶¶ III-E.3-17.**

35. RFAI methodology addresses all five attributes or characteristics of a Balanced Indigenous Population ("BIP"), which is required by the Clean Water Act. If an RFAI score reaches 70% of the highest attainable score of 60 (i.e., 42), or if fewer than half of the RFAI metrics receive a low (1) or moderate (3) score, then normal community structure and function are considered to be present, indicating that BIP is maintained. **Undisputed that this is a description of TVA's methodology for compliance with the BIP requirement. Disputed as to the fact that RFAI methodology only addresses four not five attributes, and to the consistency, accuracy, and usefulness of this methodology to portray aquatic health in the Tennessee River near WBN1. See Young Declaration, ¶¶ III-E.1-20.**

36. Second, this study evaluates the health of the aquatic environment in the WBN vicinity based on recent fish surveys and the RFAI methodology. The study found that RFAI scores from the site downstream of the WBN intake and thermal discharge have averaged 44 from 1996 to 2008 (i.e., during operation of WBN Unit 1), indicating that the aquatic health of that area is "good" even during WBN operation. **Undisputed that this is a description of TVA's RFAI study, results, and conclusions. Disputed as to the consistency, accuracy, and usefulness of this methodology to portray aquatic health in the Tennessee River near**

WBN1 and the concluding scores to properly correlate with the true health of the fish community. See Young Declaration, ¶¶ III-E.1-20.

37. Third, this study compares the health of that environment as reflected in RFAI scores from before and after WBN operation. Scores from every sample year (1993-2008) were at least 42, i.e., 70% of the highest attainable score of 60. As a result, the study concluded that both before and after WBN operation, BIP has been maintained. **Undisputed that this is a description TVA's RFAI study, results, and conclusions. Disputed as to the consistency, accuracy, and usefulness of this methodology to portray aquatic health in the Tennessee River near WBN1. See Young Declaration, ¶¶ III-E.1-20.**

38. SACE has not challenged the methodology or findings of this study with this Board. **Undisputed that SACE has not challenged the most recent iteration of the RFAI study before the Board. Contention 7, however, criticizes the methodology and results of previous RFAI studies, which have not changed in any significant respect. See Young Declaration, ¶ E-III.1.**

B. Analysis of Fish Species Occurrences in Chickamauga Reservoir – A Comparison of Historic and Recent Data (Oct. 2010) (“Fish Species Occurrences Study”)

39. SACE claimed in Contention 7 that TVA relies on inadequate and outdated data to form its conclusion that fish populations in the WBN vicinity are in good health, and has not taken steps necessary to evaluate how effluent from WBN may affect fish communities. In direct response, TVA conducted this study to analyze extensive historic and recent fish survey data from the WBN vicinity, and compare the current prevalence of fish species to historic (i.e., pre-operational) values. **Undisputed except with respect to TVA's characterization of the data as “extensive.” As discussed in Dr. Young's Declaration at pars III-E.2-3, there are significant inadequacies in the analyses found in this report.**

40. This study uses the extensive fish survey data available for the WBN vicinity, dating back to 1947. Because it also provides recent survey data for the fish populations in the WBN vicinity, this study inherently reflects the impact of the current operation of WBN Unit 1 on those populations. **Undisputed to the extent that TVA states it used fish survey data back to 1947 and provides recent survey data. Disputed with respect to TVA's characterization of the data as “extensive” and TVA's conclusion that this study alone inherently reflects the impact of the current operation of WBN1 on fish populations. See Dr. Young's Declaration throughout.**

41. In analyzing the collective historical fish survey data for the Chickamauga Reservoir, this study takes into consideration the variations in survey methods employed over the past 60 years. Variations in survey methodology preclude direct comparisons between historical and recent surveys. This study also compared the results of fish sampling efforts in various Tennessee River reservoirs subject to similar conditions to understand widespread patterns and behavior of species in reservoir environments. **Disputed. While the study may acknowledge the variations in survey methods employed over the years, it does not cure the mistakes of the past, and instead perpetuates them. TVA either has an “extensive” fish species survey/study for historical comparison, which shows significant decline of fish species overtime, including since operation of Unit 1, or TVA has an unreliable, outdated, and**

inadequate means to properly evaluate impacts from WBN. The different sampling methods do not detract from the fact that there has been a decline in fish species pre- and post-WBN operation, which is evidence that the health of the fish community is poor. *See Dr. Young's Declaration at pars. III-E.1-20.*

42. This study found that species occurrence and abundance in the Chickamauga Reservoir has changed from 1947 to 2009. Many of these changes took place before operation of WBN Unit 1 began. **Undisputed to the extent that TVA asserts that many of the changes in species occurrence and abundance in the Chickamauga Reservoir took place before the operation of WBN1 began. Disputed to the extent that TVA implies that changes after WBN1 operation began are insignificant.** *See Young Declaration, ¶¶ III-E.1-20.*

43. One major cause of this change is impoundment of the Tennessee River, which began in the 1930s and has altered habitats required for various life stages of aquatic species. Some of the species not found in recent surveys require unimpounded, free flowing riverine environments. **Undisputed to the extent that impoundment of the Tennessee River is a major cause of the decline in species occurrence and abundance. Disputed to the extent that TVA implies that changes after WBN1 operation began are insignificant.** *See Young Declaration, ¶¶ III-E.1-20 and III-D.4-7, III-D.10, and III-A.6-9.*

44. The study found that another reason for the change in species diversity and abundance is that most species that have not been collected in recent times have historically never been caught frequently or in large numbers in Chickamauga Reservoir. **Undisputed that this is a conclusion of the study. Disputed as a rationale for the decline of indigenous species present and decline of indigenous species abundance. The fact that species have not been caught in the reservoir is a meaningful indication of the decline of indigenous fish species.** *See Young Declaration, ¶¶ III-E.1-20.*

45. Finally, the study found that changes in fish survey methods account for some of the changes in findings of species occurrence and abundance. Certain survey methods, such as hoop nets, trap nets, and cove rotenone sampling, that were effective for targeting certain species, are no longer in use. **Undisputed in that this is a conclusion of the study. Disputed as being used as rationale for the decline of the fish community. Even with TVA's many changes in methods, a clear pattern of declining indigenous fish species and their abundance pre- and post-WBN operation is clear.** *See Young Declaration, ¶¶ III-E.1-20 and III-D.4-7, III-D.10, and III-A.6-9.*

46. As a result, this study concluded that there is no basis to support a finding that operation of WBN Unit 1 caused the observed changes in fish species and occurrence in the Chickamauga Reservoir. **Undisputed as to the study's stated conclusion. Disputed as to whether the conclusion is accurate that there is no basis to support a finding that operation of WBN1 caused the observed changes in fish species and occurrence.** *See Young Declaration, ¶¶ III-A.1-14, III-B.1-5, III-C.1-12, and III-E.1-20.*

47. SACE has not challenged the methodology or findings of this study with this Board. **Undisputed.**

C. Mollusk Survey of the Tennessee River Near [WBN] (Rhea County, Tennessee) (Oct. 28, 2010, Revised Nov. 24, 2010) ("Mollusk Survey"), and Discussion of the Results of the 2010 Mollusk Survey of the Tennessee River Near [WBN] (Rhea County, Tennessee) (Mar. 2011) ("Discussion of Mollusk Survey")

48. In Contention 7, SACE claimed that TVA relies on inadequate and outdated data to estimate the effects of WBN operation on mussels in the WBN vicinity. In support, Dr. Young alleged that the mussel community in the WBN vicinity is not in good health, and that TVA has not given sufficient consideration of the impact of WBN operation on that community. **Undisputed.**

49. To remedy those alleged deficiencies, TVA engaged an outside consultant to conduct a survey of the mussel community in the WBN vicinity in 2010. The consultant conducted semi-quantitative and quantitative mollusk sampling in three sample areas at which TVA has previously conducted pre-operational and operational mollusk surveys. **Undisputed.**

50. Because WBN Unit 1 was in operation in 2010 and had been in operation for more than a decade, this survey inherently reflects the impact of the operation of WBN Unit 1 on the mussel community in the WBN vicinity. **Disputed as to a one year survey capturing the population trend of a mussel community. It was reasonable for TVA to have contracted for a multi-year study when it was decided to apply for the operating license.**

51. The consultant provided the results in the Mollusk Survey. TVA subsequently produced Discussion of Mollusk Survey, analyzing the results of the Mollusk Survey and comparing those results to preoperational (1983 to 1994) and operational (1996 to 1997) monitoring of the mollusk communities at WBN. **Undisputed.**

52. These studies agree that the Chickamauga Reservoir in the WBN vicinity is not the ideal habitat for mussels. Still, the 2010 survey found that the mussel community in the WBN vicinity is in substantially similar condition as it was near the end of the previous operational monitoring period (1996 to 1997), in both species composition and the number of mussels collected. In addition, the 2010 survey collected juveniles of at least five mussel species, evidencing reproduction of mollusks in the WBN vicinity. **Undisputed as to the agreement a reservoir may not be ideal habitat for mussels. Disputed as to what results the consultant produced versus what conclusions TVA drew from that data. Disputed as to the mussel community in the WBN vicinity being in substantially similar condition as it was near the end of the previous operational monitoring period and the significance of the collection of five juvenile mussel species. See Young Declaration, ¶¶ III-D.1-7.**

53. As a result, this study concluded that there is no basis to support a finding that the relatively low densities of mussels in the WBN vicinity are the result of operation of WBN Unit 1. **Undisputed that this is the conclusion stated. Disputed as to the accuracy and reasonableness of the conclusion. See Young Declaration, ¶ III-D.4-7.**

54. SACE has not challenged the methodology or findings of this study with this Board. **Undisputed.**

D. Aquatic Environmental Conditions in the Vicinity of Watts Bar Nuclear Plant During Two Years of Operation, 1996-1997 (June 1998, Revised June 2010) (“Revised Aquatics Study”)

55. TVA completed the initial Aquatics Study in 1998, comparing pre-operational (1973 to 1979, 1982 to 1985) and operational (1996 to 1997) aquatic monitoring in the WBN vicinity. The original study focused on the effects of WBN operation on fish (juveniles and adults), benthic macroinvertebrates, and water quality. As part of the analysis of the effects on fish, the study estimated entrainment of ichthyoplankton and impingement of fish resulting from operation of WBN Unit 1. **Undisputed.**

56. The original study concluded that ichthyoplankton were present in relatively low densities in the vicinity of the WBN intake, and that those that were present had passed through the turbines of the Watts Bar Dam. The study also found that most spawning that occurs in Chickamauga Reservoir occurs downstream of the WBN intake. In other words, relatively few ichthyoplankton were available to be entrained at the WBN intake. The original study concluded that the percent of ichthyoplankton entrained was very low, and that WBN entrainment has no impact on the fish populations in the WBN vicinity. **Undisputed with respect to TVA’s description of the study. Disputed in Contention 7. Disputed as to accuracy of results and conclusions. See Young Declaration, ¶ III-A.2 and III-A.12.**

57. TVA revised this study in direct response to concerns raised by SACE in Contention 7, and by Dr. Young in support of Contention 7, that TVA’s methods for estimating entrainment were flawed. Dr. Young claimed that TVA erroneously assumed that distribution of ichthyoplankton across the reservoir is uniform, and did not take into account variations in seasonal abundance of ichthyoplankton. Dr. Young also alleged that TVA should estimate entrainment using actual intake water demand and river flow values. **Undisputed as to stated information. Disputed as to the Aquatics Study was also revised after Dr. Young identified major clerical and mathematical errors that had gone unnoticed for over a decade.**

58. In response to Dr. Young’s concerns, TVA revised the entrainment analysis to account for seasonality of ichthyoplankton occurrence and reservoir releases from Watts Bar Dam. TVA also used actual intake water demand and reservoir flow values. **Undisputed that TVA revised its entrainment analysis to account for seasonality of ichthyoplankton occurrence and reservoir releases and that TVA used actual intake water demand and reservoir flow values. Disputed as to whether TVA did, in fact, account for seasonality of ichthyoplankton occurrence prior to the Peak Entrainment Study in 2010. See Young Declaration, ¶ III-A.2.**

59. After conducting the revised entrainment estimates, TVA found that its overall conclusions regarding entrainment were unchanged. Estimated entrainment rates remained very low. For samples collected in 1996, percent entrainment in the revised analysis was estimated to be 0.29% for fish eggs and 0.57% for fish larvae. For samples collected in 1997, percent entrainment in the revised analysis was estimated to be 0.02% for fish eggs and 0.22% for fish larvae. **Undisputed that TVA has describe the results of the study. Disputed is the accuracy and validity of these results. See Young Declaration, ¶ III-A.2.**

60. TVA's experts concluded that these rates are "low" and therefore there is no impact to the ichthyoplankton populations of Chickamauga Reservoir as a result of operation of WBN Unit 1. **Undisputed as to the description of the conclusion by TVA's experts.** **Disputed as to the reasonableness of the conclusion. The data were not sufficient to support the conclusion as this study was only for a 3-month period during only 2 years, one of which Unit 1 was not even operational or only at partial-capacity for a majority of time. The Revised Aquatics Study has the same shortcomings and still arrives at the same conclusions that are disputed in Contention 7. See Young Declaration, ¶ III-A.2 and III-A.12.**

61. SACE has not challenged the methodology or findings of this study with this Board. **Undisputed.**

E. Comparison of 2010 Peak Spawning Seasonal Densities of Ichthyoplankton at [WBN] at Tennessee River Mile 528 with Historical Densities During 1996 and 1997 (Apr. 2011, Revised Nov. 2011) ("Peak Spawning Entrainment Study")

62. TVA conducted this study to respond to SACE and Dr. Young's concerns that TVA's methods for estimating entrainment were flawed, and that TVA should have taken direct measurements of entrainment. **Undisputed.** TVA collected raw data on actual entrainment at WBN during Unit 1 operation from March 2010 through March 2011, to ensure that all of SACE and Dr. Young's concerns regarding entrainment estimates were addressed, and in direct response to requests from SACE and Dr. Young for recent actual entrainment monitoring at WBN during operation of WBN Unit 1. **Undisputed with respect to the assertion that TVA collected raw data on actual entrainment at WBN1 in 2010-11. Disputed as to whether the data collected were sufficient to resolve Dr. Young's concerns. See Young Declaration, ¶ III-A.4.**

63. This study reports entrainment resulting from operation of WBN Unit 1, as measured during the peak spawning period of April through June, 2010. TVA used this timeframe to address SACE and Dr. Young's concern that TVA account for the spawning patterns of fish species in the Chickamauga Reservoir and the high abundance of ichthyoplankton during certain times of year. **Disputed with respect to the assertion that the study reports entrainment from operation of WBN1 as measured through the peak spawning period in 2010. This study only reports entrainment at the CCW, and does not report entrainment by the SCCW. Thus, the cumulative entrainment due to operation of WBN Unit1 is not known. Disputed with respect to whether the data collected were sufficient to resolve Dr. Young's concerns. See Young Declaration, ¶ III-A.5.**

64. This study concluded that measured entrainment rates at the WBN in 2010 were below one half of one percent of the ichthyoplankton population in the WBN vicinity, and consistent with those calculated for the same period during the first two years of operation of Unit 1, 1996 to 1997, when consistent calculation methods were applied. Specifically, the study found that the percent of entrained eggs in 2010 (0.12%) was within the range for 1996 (0.2%) and 1997 (0.2%). Likewise, the study found that the percent of entrained larvae in 2010 (0.40%) was within the range for 1996 (0.88%) and 1997 (0.22%). **Undisputed that TVA correctly describes the study's results. Disputed with respect to the accuracy of the results. See Young Declaration, ¶¶ III-A.2, III-A.5, and III-A.10-11.**

65. TVA's experts concluded that these entrainment rates are "very low," and are not adversely affecting the fish population in the WBN vicinity. **Undisputed that this is the conclusion by TVA's experts. Disputed as to the accuracy and reasonableness of the conclusion. See Young Declaration, ¶ III-A.1-12.**

66. The increased water intake demand for the CCW caused by dual unit operation will result in an estimated increase in hydraulic entrainment of approximately 0.2%. This study found that ichthyoplankton entrainment will increase proportionately with hydraulic entrainment. This increase will result in entrainment percentages that are still less than 1% of the ichthyoplankton population. This study concluded that, as a result, dual unit operation will not result in a material change in entrainment impacts. **Disputed as to the accuracy and reasonableness of this conclusion, and the rationale/methodology to arrive at this conclusion. See Young Declaration, ¶ III-A.13-14.**

67. SACE has not challenged the methodology or findings of this study with this Board. **Undisputed.**

F. Fish Impingement at [WBN] Intake Pumping Station Cooling Water Intake Structure During March 2010 through March 2011 (Mar. 2011, Revised Apr. 2011) ("Impingement Study")

68. This study analyzes raw impingement data collected at the CCW intake during operation of WBN Unit 1 from March 2010 through March 2011. **Undisputed.** TVA used this data, in combination with the existing recent SCCW impingement data, to estimate the annual impingement mortality of fish in the vicinity of WBN as the result of operation of WBN Unit 1, and to predict the impact from operation of Unit 2. **Disputed as to the fact that TVA did not update the SCCW impingement in conjunction with the CCW impingement in this study.** TVA conducted this study in response to allegations by SACE and Dr. Young that TVA's analysis of the effects of WBN operation on the aquatic community was deficient because TVA had not conducted recent studies of actual impingement at the CCW intake. **Undisputed with respect to the assertion that TVA conducted the study. Disputed as to whether the study was sufficient to resolve Dr. Young's concerns. See Young Declaration, ¶ III-B.1-5.**

69. This study found that total impingement values in 1996 to 1997 (161) were less than those measured in 2010 to 2011 (13,573). This study also found, however, that mortality resulting from a cold shock event dominated impingement mortality at WBN in 2010 to 2011. Shad in the Southeastern United States, including the Chickamauga Reservoir, are susceptible to cold shock. When temperatures fall below 50°F, they become lethargic and more susceptible to impingement. The study found that the most significant impingement events observed at WBN in 2010 to 2011 were the result of cold shock. **Undisputed as to the accuracy of TVA's description of the study's conclusions. Disputed as to the implication that cold shock, not the operation of WBN1, is the most significant cause of impingement mortality. See Young Declaration, ¶ III-B.1-4.**

70. Excluding the cold shock event, this study found that fewer fish and number of species were impinged in 2010 to 2011, than in 1996 to 1997. The EPA endorses an impingement modeling approach that excludes the effects of extreme environmental conditions.

The EPA also acknowledges the effects of cold shocks on shad. **Disputed as to the cause of mortality. The mortality was caused by impingement against a man-made structure due to intake flow velocities not just the physiological consequences of cold temperatures. See Young Declaration, ¶ III-B.1-4.**

71. This study concludes that low numbers of impinged fish in both 1996-97 and 2010-11 indicate that impingement resulting from operation of WBN Unit 1 will not materially affect fish populations in the WBN vicinity. **Disputed as to the reasonableness of the study duration being adequate to determine this conclusion, and as to the reasonableness of the conclusion. See Young Declaration, ¶ III-B.1-5.**

72. Dual unit operation will result in increased withdrawal of water through the CCW intake channel. Impingement will likewise increase at a rate that is proportional to the increase in flow rate. This study concluded that the impingement increase from dual unit operation would still be very small when compared to the effects of cold shock and winter kills on shad. As a result, TVA's experts concluded that operation of Unit 2 will not result in material increases in impingement at WBN. **Disputed as to this methodology that was also used similarly by TVA to arrive at conclusions of entrainment from the combined operation of Unit 1 and 2. See Young Declaration, ¶ III-A.13-14.**

73. SACE has not challenged the methodology or findings of this study with this Board. **Undisputed.**

G. Hydrothermal Effects of the Ichthyoplankton from the Watts Bar Nuclear Plant Supplemental Condenser Cooling Water Outfall in Upper Chickamauga Reservoir (Jan. 2011) ("Hydrothermal Study")

74. This study analyzes the hydrothermal impacts of WBN operation, based on in-river testing in the vicinity of the WBN outfall during WBN operation in May and August, 2010. TVA conducted this study in direct response to claims by SACE and Dr. Young that TVA should study the hydrothermal effects of operation of WBN Unit 1 on the aquatic environment in the WBN vicinity. Dr. Young alleged that TVA does not provide data on spatial or temporal distribution of ichthyoplankton in relation to thermal mixing zones, does not evaluate the impact of discharge temperatures on ichthyoplankton, and does not account for impacts of variations in the size or temperature profile of the mixing zone. **Undisputed**

75. In direct response to these claims, TVA designed this study to document the flow patterns and characteristics of the thermal plume from WBN, and track the thermal plume in conjunction with ichthyoplankton sampling. This allowed TVA to understand the temporal and spatial distribution of ichthyoplankton and exposure rates to thermal discharges. **Disputed as to the fact that TVA failed to study the thermal discharge from Outfall 101 in conjunction with Outfall 113 to encompass the cumulative thermal discharge from WBN, and failed to address exposure rates and the effects of abrupt temperature changes on ichthyoplankton in this study. See Young Declaration, ¶ III-C.3-4.**

76. TVA conducted this study in May and August, 2010, because those time frames represented extreme conditions: peak abundance of fish eggs and larvae, near maximum ambient water temperatures, and no release from the upstream Watts Bar Dam. **Undisputed as to**

timeframe of study. **Disputed as to whether this would be representative over time as this study only represents a few points in time, not adequately addressing environmental variability. See Young Declaration, ¶ III-C.2.**

77. This study found that, even under these extreme conditions, water temperatures did not approach the limits established by TVA's NPDES permit for operation of WBN Units 1 and 2. **Disputed as study results directly stated to the contrary. See Young Declaration, ¶ III-C.11.** Because discharge temperatures did not exceed those set in TVA's NPDES permit, this study concluded that there was no risk of thermal damage to ichthyoplankton from operation of WBN. **Disputed as to accuracy and reasonableness of these conclusions. See Young Declaration, ¶ III-C.1-11.**

78. Even if operation of WBN Units 1 and 2 causes effluent temperatures to rise above those measured even under extreme conditions for Unit 1, TVA is bound by its NPDES discharge limits. Accordingly, dual unit operation does not pose any greater risk of thermal damage to the aquatic community in the WBN vicinity than does operation of Unit 1 alone. **Disputed as to accuracy and reasonableness of these conclusions. See Young Declaration, ¶ III-C.1-11.**

79. SACE has not challenged the methodology or findings of this study with this Board. **Undisputed.**

IV. Overview of the Draft SFES Conclusions Regarding TVA's Aquatic Studies

80. As noted previously, the NRC Staff's Draft SFES concurs with the findings presented in TVA's aquatics studies. **Undisputed.**

81. Specifically, the Staff concurred with TVA's findings regarding entrainment impacts, concluding in the Draft SFES that hydraulic entrainment would have a very minor impact on the aquatic biota in the vicinity of WBN. The Staff agrees that existing levels of measured entrainment under Unit 1 operation are too low to be readily detected in the aquatic populations in the WBN vicinity, and the additional water withdrawn via the CCW intake will not be noticeable or furthermore destabilizing to the aquatic ecology in the WBN vicinity. Moreover, the Staff concludes that the water withdrawn from the SCCW intake will actually decrease under dual unit operation. In drawing these conclusions, the Staff relies in part on the Revised Aquatics Study and the Peak Spawning Entrainment Study. **Undisputed. It should be noted that the NRC Staff has not conducted any independent studies to support its conclusions.**

82. The Staff's conclusions regarding impingement impacts are similar. The Staff finds that measured levels of impingement under operation of WBN Unit 1 are low and impingement effects are too minor to be readily detected in aquatic populations in the WBN vicinity. The increased flow rates for the CCW intake under dual unit operation will not alter that conclusion, concludes the Staff, and the decreased flow rates for the SCCW intake will not increase impingement effects. The Staff relied in part on the Impingement Study in drawing these conclusions. **Undisputed. It should be noted that the NRC Staff has not conducted any independent studies to support its conclusions.**

83. With respect to thermal impacts from operation of WBN Unit 2, the Staff concludes that this effect also will be undetectable and will not destabilize or noticeably alter the aquatic biota in the WBN vicinity. The Staff based this conclusion in part on the Hydrothermal Study, as well as limits set by the NPDES permit. **Undisputed. It should be noted that the NRC Staff has not conducted any independent studies to support its conclusions.**

84. The Staff concludes in the Draft SFES that although the impoundments and industrial facilities have a significant cumulative impact on the aquatic biota in the WBN vicinity, "the overall impacts on aquatic biota, including Federally listed threatened and endangered species, from impingement and entrainment at the SCCW and IPS [i.e., CCW] intakes and from thermal . . . discharges as a result of operating Unit 2 on the WBN site are SMALL." **Undisputed. It should be noted that the NRC Staff has not conducted any independent studies to support its conclusions.**

Respectfully submitted,

Electronically signed by

Diane Curran

HARMON, CURRAN, SPIELBERG, & EISENBERG, L.L.P.

1726 M Street N.W., Suite 600

Washington, D.C. 20036

202-328-3500

Fax: 202-328-6918

e-mail: dcurran@harmoncurran.com

December 20, 2011

December 20, 2011

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, Ph.D. I have been retained by Southern Alliance for Clean Energy ("SACE") as an expert consultant in this matter. I submit this declaration as a private consultant to SACE in this matter.
2. I am currently employed as a Fish Biologist for the Kootenai Tribe of Idaho. I also maintain a private environmental consulting business. My current business address is P.O. Box 507, Bonners Ferry, Idaho 83805.
3. My professional and educational experience is summarized in the curriculum vitae attached to this declaration. To summarize, 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 fourteen years of experience researching the effects of human activities on fisheries and aquatic ecosystems. In addition to my professional qualifications, I am an avid outdoorsman. I have fished, hunted, and enjoyed nature in every manner since my early childhood.

4. As listed in my curriculum vitae, I have authored and published peer-reviewed articles and reports 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 delivered scientific presentations at numerous professional meetings, academic seminars, and citizen fishing association functions.

5. I am familiar with the application of Tennessee Valley Authority ("Applicant" or "TVA") for an Operating License ("OL") at the Watts Bar Nuclear Plant site and related documents, including TVA's 2007 Final Supplemental Environmental Impact Statement ("FSEIS"); the Draft Final Environmental Statement ("DFES") issued by the NRC Staff in December 2011; and the Joint Affidavit of TVA staff, Dennis Scott Baxter and John Tracy Baxter, and experts, Dr. Charles Coe Coutant and Dr. Paul Neil Hopping, supporting TVA's Motion for Summary Disposition of Contention 7. I have reviewed these documents with particular reference to their description and analysis of the additional unit's expected heat budget, water intake, water consumption, and thermal discharge into the Tennessee River; and the proposed reactor's potential impacts on the aquatic organisms of the Tennessee River.

6. I am providing this declaration in support of Intervenor's Contention 7 -- Impacts on Aquatic Resources of the Tennessee River. That contention and its supporting declaration expressed my view that TVA's conclusion in the FSEIS that the cumulative impacts of WBN Unit 2 on aquatic ecology will be insignificant is not reasonable or adequately supported. My opinion was based on three fundamental problems with TVA's data and analysis. 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 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. This declaration explains the basis for my scientific opinion that the concerns I raised in Contention 7 have not been resolved by the studies cited in TVA's Motion for Summary Disposition, the NRC Staff's DFES, or the Joint Affidavit submitted by TVA's experts.

7. I have arrived at my conclusions dealing with the matters stated herein based upon material fact found within the documents related to Watts Bar Nuclear Units 1 and 2, and within relevant scientific literature produced by other scientists pertaining to this subject, and believe them to be true and correct. The opinions and conclusions I express in this affidavit are my own and should not be attributed to any other person or entity.

II. SUMMARY OF MY PROFESSIONAL OPINION REGARDING TVA'S ASSERTIONS.

1. Relying on several studies that it has conducted in response to Contention 7, as well as the DFES, TVA claims that it has resolved the three major deficiencies identified in Contention 7. But this is not correct.

2. With respect to the inadequacy of TVA's previous data and analyses, TVA has made some progress by collecting new data on entrainment, impingement, freshwater mussels, and thermal impacts during 2010. But TVA has only started to catch up with its failure to collect the appropriate data that would be reasonably sufficient to evaluate impacts on aquatic resources by collecting only one year of data for entrainment, impingement, freshwater mussels, and thermal impacts over the preceding years. TVA still has not collected an amount of data that is reasonably necessary to evaluate the effects of WBN1 on aquatic organisms in the Tennessee

River, and therefore it does not have enough information to extrapolate the impacts of WBN2.

See pars. III-A.5, III-B.3-4, and III-C.1-2 below.

3. In addition, there are still big gaps in the information that TVA has collected. For example, TVA collected entrainment data for the Condenser Cooling Water (“CCW”) system only and did not include the Supplemental Condenser Cooling Water (“SCCW”) system. See par. III-A.4 below. In addition, TVA did not collect impingement data for all key locations. See par. III-B.5 below. And TVA’s Hydrothermal Study does not address important parameters such as Outfall 101 or the amount of time that fish larvae remain in the thermal plume. See par. III-C.4 below.

4. Finally, TVA’s description of its method of analyzing aquatic impacts indicates a troubling lack of care or competence. For example, by adding widely divergent diurnal and nocturnal entrainment measurement, TVA violates guidance of the U.S. Environmental Protection Agency (“EPA”) and grossly overstates the size and diversity of the fish population. See pars. III-C.6 and III-C.10 below. Some of the studies relied on by TVA had to be revised after they were released, indicating that TVA has significant problems ensuring the quality of its measurements and analyses. See pars. III-A.2 and III-A.11, and pars. III-C.6-9 below. It is reasonable to expect that the results from TVA’s biological studies will be accurate in order to support TVA’s conclusions. In too many instances, however, TVA makes significant mistakes.

5. With respect to TVA’s mischaracterization of the health of the aquatic environment as good, TVA has done nothing to alleviate my concern. Although as discussed above, TVA’s data collection is insufficient to present a reasonable picture of the health of the Tennessee River, the data that TVA has collected do not indicate, as TVA claims, that WBN1’s impacts on the aquatic

ecosystem have been insignificant. Rather, they point to already-significant aquatic impacts by WBN1 that are likely to be significantly exacerbated by the operation of WBN2.

6. Further, despite alarming evidence of significant decline in the diversity and numbers of aquatic organisms in the Tennessee River in the vicinity of WBN, TVA continues to assert that the aquatic health of the river is good. The only way that TVA can present such a clean bill of health is to mischaracterize the baseline condition of the Tennessee River as a large reservoir where one would expect to see a limited number of species of aquatic organisms. In reality, the Tennessee River is a fragile and rapidly deteriorating riverine ecosystem with remnants of the greatest species diversity of any river in the United States. By falsely painting a rosy picture of aquatic health in the river, TVA understates the significance of the impacts of WBN1 and WBN2, and thus minimizes the benefits that could be achieved by implementing alternatives that would reduce the impacts of the cooling system on organisms in the river.

7. Finally, TVA still does not 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. The combined operation of WBN1 and WBN2, by itself, may cause changes in how Watts Bar Dam is operated. TVA and the NRC Staff both acknowledge that in order to stay within thermal discharge limits stated in the NPDES that requests for additional discharge from Watts Bar Dam may be needed. Thus, operating WBN alone would change reservoir operations in the middle- Tennessee Basin that would be supported by water releases or hydrological adjustments in upper-Tennessee River Basin. The effects of more alterations to the hydrological cycle of the basin on aquatic organisms, especially the already declining native fish

and freshwater mussel species, must be addressed. Given the extensive portfolio of energy and industrial facilities that the Tennessee River supports and that the management agencies must maintain adequate water for all these facilities, this is an extremely important omission.

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

Over the past two years, TVA has conducted or revised eight studies which it claims to resolve the concerns raised by Contention 7. The studies are the following:

- Aquatic Environmental Conditions in the Vicinity of Watts Bar Nuclear Plant During Two Years of Operation, 1996-1997 (June 1998, Revised June 2010) ("Revised Aquatics Study")
- Comparison of 2010 Peak Spawning Seasonal Densities of Ichthyoplankton at [WBN] at Tennessee River Mile 528 with Historical Densities During 1996 and 1997 (Apr. 2011, Revised Nov. 2011) ("Peak Spawning Entrainment Study")
- Fish Impingement at [WBN] Intake Pumping Station Cooling Water Intake Structure During March 2010 through March 2011 (Mar. 2011) ("Impingement Study")
- Hydrothermal Effects of the Ichthyoplankton from the Watts Bar Plant Supplemental Condenser Cooling Water Outfall in Upper Chickamauga Reservoir (Jan. 2011) ("Hydrothermal Study")
- Mollusk Survey of the Tennessee River Near [WBN] (Rhea County, Tennessee) (Oct. 28, 2010, Revised Nov. 24, 2010) ("Mollusk Survey")
- Results and Discussion of the 2010 Mollusk Survey of the Tennessee River Near [WBN] (Rhea County, Tennessee) (Mar. 2011) ("Discussion of Mollusk Survey")
- Comparison of Fish Species Occurrence and Trends in Reservoir Fish Assemblage Index Results in Chickamauga Reservoir Before and After WBN Unit 1 Operation (June 2010) ("RFAI Study")
- Analysis of Fish Species Occurrences in Chickamauga Reservoir – A Comparison of Historic and Recent Data (Oct. 2010) ("Fish Species Occurrences Study")

As discussed below, these studies do not resolve the concerns raised in Contention 7.

A. Revised Aquatics Study and Peak Entrainment Study

1. TVA asserts that it has revised its method for estimating entrainment impacts and has also collected raw data on actual entrainment associated with WBN1 for one year. TVA Motion at 14-15. TVA asserts that these studies show the rate of entrainment is very low. *Id.* In my professional opinion, however, TVA's studies do not provide a reasonable degree of support for the conclusion that the rate of entrainment is low. In fact, they indicate a rate of entrainment that is unacceptable.

2. The Revised Aquatics Study is a revision of the "Aquatics Study" for which TVA collected ichthyoplankton data in order to estimate entrainment at WBN Unit 1 only during April – June 1996 and 1997, not the entire year, a major shortcoming. The timing of the original Aquatic Study corresponded to the commencement of operation of WBN Unit 1. The study results were published in 1998. TVA concluded that WBN Unit 1 ichthyoplankton entrainment was low and had insignificant impacts on the fish community. In 2009, I identified major errors in this document that had major implications. TVA revised this study, and released a revision in 2010 that did not include an additional level of detail for data presentation and analysis to assess whether the errors were properly rectified. Further, TVA's conclusions remained unchanged. Based upon the original erroneous document, in 1998, TVA convinced the Tennessee Department of Environment and Conservation ("TDEC") to allow termination of the entrainment monitoring program mandated in the original NPDES permit. Therefore, since 1997, TVA had not collected any post-operational entrainment study at Unit 1.

3. After SACE's contention 7 was admitted, TVA conducted one year of entrainment monitoring during 2010 to compare the results against 1996 and 1997 entrainment data. The Peak Entrainment Study was a survey of the ichthyoplankton drift past the Supplemental Condenser Cooling Water ("SCCW") discharge (Outfall 113) and the Unit 1 water intake

pumping structure for the CCW system. The Peak Entrainment study was conducted in conjunction with the “Hydrothermal Study” in order to also determine ichthyoplankton abundance at the SCCW intake, and in the SCCW discharge under two different thermal mixing zone scenarios.

4. In the Peak Entrainment Study, TVA collected ichthyoplankton along a transect from riverbank to riverbank below the SCCW discharge plume and above the intake pumping structure (IPS) for the CCW. As such, the study provides only a minimal account of the conditions in the Tennessee River. In order to make a reasonable analysis of the impacts of WBN1 on the river and the likely impacts of WBN2, TVA should have been collecting entrainment data regularly since WBN1 went online in 1996. For any reasonable biologist, two measurements taken thirteen years apart would not provide a sufficient basis for an analysis of entrainment impacts. TVA should have collected data for at least three years after WBN1 began operating in order to determine any annual variability of ichthyoplankton abundance. And TVA should have updated those measurements after it decided to pursue an operating license for WBN2, with at least two more years of measurements.

5. TVA’s data collection for the Peak Entrainment Study was incomplete because TVA reported entrainment measurements only for the CCW intake. Even though TVA collected ichthyoplankton samples at the SCCW intake and in Watts Bar forebay, TVA did not present the data or calculate entrainment rates for the SCCW within the Peak Entrainment Study. Instead, TVA only presented data on ichthyoplankton abundance near the SCCW intake within the Hydrothermal Study, and again did not present any entrainment rates. Thus, TVA failed to adequately estimate total entrainment at the WBN1 water intake structures. The omission is significant because Tables 2 and 3 of the “Hydrothermal Study” list the results of

ichthyoplankton abundance at and near the SCCW intake in Watts Bar Reservoir forebay. The results listed in the hydrothermal study show that 300% more fish larvae were captured at the SCCW intake on May 11-12, 2010 (Table 3) than were captured in the forebay nearby (Table 2). This indicates that a very high level of entrainment may be occurring at the SCCW intake. TVA, however, failed to recognize this significant material fact.

6. In any event, the results that TVA reported for the CCW intake show that WBN1 has had significant impacts on the aquatic environment and that operation of WBN2 is also likely to impose significant additional impacts. First, the Peak Entrainment Study shows that ichthyoplankton abundance in the vicinity of WBN has declined significantly since operation of WBN1 commenced. The abundance of ichthyoplankton was substantially lower in 2010 than in post-operational surveys during years 1996 and 1997 as calculated and listed by TVA in the Revised Aquatics Study. As stated in the Peak Entrainment Study at page 3 with respect to fish larvae:

Average densities (525, 924, 282), peak seasonal densities (1,387; 1,699; 828) and dates of peak densities (06/03, 05/15, 05/16) for larvae during April through June 1996, 1997, and 2010, respectively, are presented in Table 5. *All of these values for samples collected during 2010 were slightly lower than the range of the two previous years (1996 and 1997) of monitoring.*

(emphasis added). TVA and the NRC Staff failed to properly acknowledge the significant decline as a very important material fact in their respective analyses and conclusions.

7. The Peak Entrainment Study also reported a decline in the number of fish eggs between 1996 and 2010: average densities were reported as 262, 150, and 75 and peak seasonal densities were reported as 1,095, 1,004, and 811 for April through June 1996, 1997, and 2010, respectively. The significance of this decline is not discussed by either TVA in its Motion or the NRC Staff in the DES.

8. Based on the data reported in the Peak Entrainment Study, (Table 7, p. 19), larger than anticipated entrainment events occurred at WBN1. Daily entrainment rates of fish larvae were as high as 8.65% (June 21, 2010) during peak ichthyoplankton abundance. In my professional opinion, such a high rate of entrainment may have adverse impacts on the fish community. This measurement is very significant, given that hydraulic entrainment will double at the IPS for the CCW with the addition of WBN2, likely doubling ichthyoplankton entrainment. Larval fish entrainment events may double from 8.5% to 17%, a rate of entrainment that would certainly have a significant impact on the health of the fish population.

9. The Peak Entrainment Study also reported in Table 7 that daily entrainment rates of fish eggs were as high as 4.08% (May 16, 2010) during peak ichthyoplankton abundance. In my professional opinion, an egg entrainment rate of 4% is high enough to have a potentially adverse impact on the fish community. This measurement is very significant, given that hydraulic entrainment will double at the IPS for the CCW with the addition of WBN2, likely doubling fish egg entrainment events from 4.0% to 8.0%. At 8%, the impacts would indeed be significant.

10. I am also concerned about potential errors in the Peak Entrainment Study. At page i, TVA stated that another revision should be released sometime this month, December 2011. This indicates to me that there may be more errors in the study.

11. Further, I identified errors in methodology TVA used to complete calculations in the “Hydrothermal Study” which may have consequences for the Peak Entrainment Study. Both studies should have used the same formula to calculate the number of ichthyoplankton within 1,000 m³ of source water from the number of organisms actually captured in the volume of water actually sampled to catch those organisms. Within the Hydrothermal Study, the number of ichthyoplankton density per 1,000 m³ of water was estimated to determine how many fish eggs

and fish larvae were exposed to high water temperatures in the SCCW thermal plume during the day and during the night. To arrive at an estimate of the daily abundance per 1,000 m³ of water, the day and night estimates should have been averaged, not added together. See pars. III-C. 6-9, below in this declaration. Thus, results for daily ichthyoplankton abundance at the SCCW intake are incorrect; and since the two studies incorporate similar methods to estimate ichthyoplankton densities, similar errors in calculations may have been made in the Peak Entrainment Study also. However, the entrainment study lists results in a different manner that does not allow one to determine this.

12. In conclusion, the Revised Aquatic Study and the Peak Entrainment Study do not support TVA's conclusion that the environmental impacts from entrainment at the current IPS for the CCW intake with one reactor are insignificant, nor do they support a conclusion that the additional impacts of WBN2 would be insignificant. To the contrary, the data reported shows that the impacts from entrainment from the IPS for the CCW from one reactor unit alone may be large and warrants further investigation. Further, the Hydrothermal Study suggests that entrainment at the current SCCW intake may be also be significant with large impacts to the fish community.

13. As a general matter, TVA also mischaracterizes the relationship between river flow and entrainment. According to TVA, studies show that the hydraulic entrainment from dual unit operation will result in an additional entrained amount of 0.2% of the flow in the Chickamauga Reservoir. Statement of Material Facts, par. 22. TVA asserts that the resulting total hydraulic entrainment represents approximately 0.5% of the flow in the Chickamauga Reservoir; and that this increased hydraulic entrainment will result in a proportionate increase in entrainment of the ichthyoplankton present in the water column. *Id.*

14. TVA's calculation is only partly correct, and only accurate at a very specific river flow past WBN Plant. The 0.2% hydraulic entrainment for WB1 is based upon TVA using "a long term average river flow past WBN of 27,000 cfs." See Footnotes 58-60 and Joint Affidavit par. 37. However, the flow past WBN may vary widely depending on seasonal precipitation levels and daily operations of Watts Bar Dam immediately upstream of WBN. Therefore, hydraulic entrainment will vary depending on amount of water in the Tennessee hydrosystem and how much flow is released from Watts Bar Dam. For instance, using CCW water withdrawal rate of 88 cfs (NRC DFES Table 3-1 at page 3-9) and river flow of 3,500 cfs, which is the minimum amount of flow from Watts Bar Dam that permits TVA to discharge thermal and chemical effluent through Outfall 101, the hydraulic entrainment increases to 2.5% (12.5 times higher). Then, with the addition of Unit 2 doubling hydraulic entrainment, the hydraulic entrainment at a flow of 3,500 cfs further increases to approximately 5.0% (25 times higher). Also, with higher hydraulic entrainment, the probability of entraining more ichthyoplankton increases. However, one cannot assume that ichthyoplankton entrainment will increase proportionately. In fact, ichthyoplankton may increase exponentially. The increase depends on the proximity of ichthyoplankton to water intakes. Only data collected by field studies in combination with proper methods for calculation may accurately characterize ichthyoplankton entrainment under any level of hydraulic entrainment. I note that this is a similar issue in regards to impingement.

B. Impingement Study

1. TVA claims that impingement data it collected between March 2010 and March 2011 at the CCW intake show that impingement rates under normal conditions were unchanged from those that TVA historically measured at the CCW intake, but that unusually cold weather in the winter of 2011 produced high impingement rates. TVA also cites the DES for the proposition

that impingement impacts during operation of both WBN1 and WBN2 would be “too low to noticeably alter the aquatic community”. TVA Motion at 16-17.

2. I disagree with TVA that the Impingement Study provides sufficient data on which to reach a conclusion about impingement impacts of either WBN1 or dual operation of WBN1 and WBN2.

3. Although WBN1 has been operating since 1996, the last time TVA took an impingement measurement for the CCW was in 1997. Although TVA has planned for some time to finish building and operate WBN2, it made no effort to measure impingement rates until 2010, after Contention 7 was admitted for a hearing. For any reasonable fish biologist, two measurements taken more than ten years apart would not suffice to provide the basis for any analysis of the impingement impacts of WBN1.

4. The circumstances of the 2010 measurements illustrate my point. In comparison to the 161 fish impinged in March 1996 through 1997, 13,573 were impinged in 2010. See Attachment 15, page 3. TVA attributes this exponential increase to cold weather in 2010. But it is also possible that the through-screen velocity of water flowing into the CCW intake is partially responsible for the high impingement rate. At page 1, the Impingement Study lists the through-screen velocity as 0.67 fps. The EPA recommends that through-screen velocity be kept below 0.5 fps, however, in order to reduce entrainment and impingement. Without more data over a period of several years, the contribution of the cold and plant operating conditions to the rate of impingement can only be guessed at. In short, it is not possible for TVA to make up for years of neglect in only one year.

5. TVA also failed to take impingement measurements for all key locations. The Impingement Study sampled fish impingement at the IPS for the CCW only, and did not include

the SCCW. A study was conducted in 2000 to evaluate impingement at the SCCW intake above Watts Bar Dam; however, this study did not monitor an entire year. This study still showed that impingements may also occur at the SCCW intake (p. 6, Watts Bar Nuclear Plant Supplemental Condenser Cooling System Fish Monitoring Program, January 2001); yet, TVA still did not conduct impingement monitoring at the SCCW during 2010 in conjunction with the CCW study to determine the cumulative impingement by current operations of WBN Unit 1.

C. Hydrothermal Study

1. In the Hydrothermal Study, TVA reports the results of monitoring the water temperatures in the thermal plume of the SCCW (Outfall 113) during May and August 2010. TVA recorded water temperatures during the two mixing zone scenarios that occur daily, the active mixing zone when Watts Bar Dam releases water and the passive mixing zone when Watts Bar Dam does not release water. TVA also completed ichthyoplankton sampling at and near the SCCW above Watts Bar Dam, and downriver of Watts Bar Dam below the actual thermal plume during both day and night. TVA asserts that the Hydrothermal Study shows that thermal discharges from WBN1 and WBN2 will not have a significant impact on aquatic organisms. TVA Motion at 18-19.
2. TVA should have conducted the study over several years to characterize thermal plume water temperatures and ichthyoplankton abundance that may vary across years due to variable climatic conditions, and due to variable operations of Watts Bar Dam caused by variable hydrological conditions in the Tennessee River Basin.
3. The Hydrothermal Study also failed to address important parameters. For instance, it did not include any data or analysis for Outfall 101 (discharge at the CCW diffuser), which releases heated effluent when the dam discharge exceeds 3,500 cfs. Outfall 101 should have been

included, especially in light of the fact that ichthyoplankton may drift through Outfall 113 mixing zone and then into the Outfall 101 mixing zone. This omission is significant.

4. In addition, contrary to statements in the Motion for Summary Disposition and the DFES, the Hydrothermal Study did not list nor discuss ichthyoplankton exposure rates i.e., the amount of time fish eggs and larvae remain in the thermal plume. The omission of this information is significant because the early life stages of fish, especially eggs and larvae are vulnerable to abrupt temperature change such as those found at Outfall 113 and 101, and exposure to such water temperature changes caused by WBN heat waste discharge may cause high mortality rates. Abrupt temperature changes are detrimental to fish eggs and larvae. Also, abrupt temperature change affects species differently. This is an important omission because a rapid increase of 5 – 10° F can kill fish eggs and fish larvae, and from the data presented, most of the ichthyoplankton likely experienced this as they drifted through the SCCW mixing zone. Further, not only are ichthyoplankton exposed to the SCCW thermal plume, but these same fish eggs and larvae then drift through the CCW diffuser thermal plume below. A second abrupt temperature increase further elevates risk of mortality from the heat discharged from WBN.

5. The Hydrothermal Study is also deficient because TVA failed to report and discuss the fact that an alarming number of ichthyoplankton were likely entrained by the SCCW and subsequently killed by heat within the SCCW system before being discharged back into the river. This is an extremely important consideration in this matter. Further, the portion of ichthyoplankton in the Watts Bar Reservoir forebay not directly entrained and killed by the SCCW would likely pass through the dam and then still would be subjected and potentially killed by the waste heat in the SCCW and CCW (Outfalls 113 and 101) thermal plumes. The use of the SCCW creates a “double whammy” for fish eggs and larvae, likely causing an

alarming level of mortality. TVA does not adequately describe this situation or adequately analyze presented data that shows significant mortality may be occurring via both pathways.

6. The conclusions of the Hydrothermal Study are also based on incorrect methodology that leads to distorted results. In reporting the results of ichthyoplankton sampling, TVA added the daytime and nighttime measurements rather than averaging them, thus giving a distortedly high population reading. For instance Table 4 on page 25 of the Hydrothermal Survey shows that on May 11-12, 2010, during daytime sampling, TVA estimated 75 organisms per 1,000 m³ of water at the SCCW outfall. During the nighttime sampling, TVA estimated 8,232 organisms for the same volume of water. TVA then reported the number of organisms per volume of 1,000 m³ of water for the sampling period as 8,307. In actuality, however, the number of organisms ranged between 75 and 8,232, with an average of approximately 4,153 fish larvae per 1000 m³ of water during a 24-hour diel cycle.

7. There is no controversy about what method TVA should have employed – it is listed in the “Materials and Methods” section of TVA’s April 2011 “Peak Entrainment Study.” For TVA not to notice another significant error in its own reporting raises fundamental questions regarding TVA’s methodology for all of its studies.

8. TVA’s methodological error has several implications in the analyses of impacts on the fish community. This error results in the overstatement of the size of the fish population in the river, which in turn will lead to an understatement of the percentage of fish that are affected by entrainment. This has major implications for the validity of the “Entrainment Study” because it results in an incorrect estimate of the percentage of organisms that were entrained at the CCW. If the same error found in the Hydrothermal Study was made during calculations of ichthyoplankton abundance for the Peak Entrainment Study, the results listed in the Peak

Entrainment Study are not accurate, and TVA conclusions are not based on accurate material facts. In addition, the original Aquatics Study also had major errors, and one cannot be sure those errors have been remedied in the Revised Aquatics Study. Both documents used to compare post-operation entrainment and the associated impacts have had major errors casting doubt on the validity of TVA's analyses and conclusions.

9. Another significant error can be found in Tables 5 through 10. Table 10 lists the total ichthyoplankton abundance found at the five different sampling stations across the survey transect. However, the reported total number of ichthyoplankton captured is less than the reported number of ichthyoplankton that were captured at just *one* of the individual sampling stations. This error raises serious questions about the actual results of the study, not to mention TVA's competence and quality assurance procedures for conduct of biological monitoring and analysis.

10. TVA also failed to note the significance of the great discrepancy between the daytime and night-time population measurements, or to analyze how they may be affected by daily variations in thermal plume temperature. In light of the size of the discrepancy, TVA should have undertaken more studies of the differences between daytime and nighttime fish populations. It should also evaluate changes in nighttime operations to reduce the rate of entrainment of aquatic organisms.

11. The Hydrothermal Study showed that thermal discharge observed for current operation of Unit 1 is already near the limits set in the NPDES permit. TVA's temperature data shows that it is staying within its permit limit of a 5°F daily average change from upriver temperature at the downstream edge of the mixing zone; however, the results from the May and August 2010 tests show that it is operating on the edge of those limits with only Unit 1 operating. As stated at

page 5, the maximum difference between ambient and surface temperature reached 5°F during the May night test, 5.34°F during the May day test, and 5.36°F during the August day test. Also, at the point of discharge, the Hydrothermal Study shows that SCCW discharge water is 10°F hotter than the water above the SCCW thermal plume and above Watts Bar Dam. Organisms drifting downriver nearest the point of discharge will likely suffer from this abrupt temperature change, especially fish eggs and larvae. These impacts were not considered by TVA. See above in par. 4.

D. Mollusk Survey, Discussion of Mollusk Survey, and Revised Aquatics Study

1. As discussed in Contention 7, TVA's assertion in the FEIS that mussel health is "excellent" because their population is "constant" is contradicted by evidence that mussel populations are declining. Contention 7 at page 33. TVA responded to my criticism by hiring a consultant to conduct a new mussel survey utilizing new and expanded methodology. The study site evaluated mussel beds within transects in the same general areas as previous TVA mussel surveys near WBN Plant. Each mussel was identified by species and age. TVA compared the results from the 2010 study with previous mussel studies, including the post-operational mussel surveys in 1996 and 1997. The results from the 1996 and 1997 post-operational surveys are found within the original "Aquatic Study" published in 1998 and the recent "Revised Aquatics Study".

2. TVA no longer asserts that mussel health near WBN1 is excellent. Instead, it states that the studies it conducted "agree that the Chickamauga Reservoir in the WBN vicinity is not the ideal habitat for mussels." Statement of Material Fact, page 19. Nevertheless, TVA's experts state that the survey results demonstrated "that the current mussel community adjacent to WBN is stable and that some species are reproducing." Baxter and Coutant, par. 72. They assert that

the mussel community in the WBN vicinity is in “substantially similar condition as it was near the end of the previous operational monitoring period (1996 to 1997), in both species composition and the number of mussels collected.” In addition, they state that the 2010 survey “collected juveniles of at least five mussel species, evidencing reproduction of mollusks in the WBN vicinity.” *Id.* Based on these results, TVA contends that “there is no basis to support a finding that the relatively low densities of mussels in the WBN vicinity are the result of operation of WBN Unit 1.”

3. I disagree with TVA’s assertions. The data collected by TVA show that health of the freshwater mussel community around WBN1 is poor and declining. The data also show a connection between the poor health of the mussel community near WBN1 and the operation of WBN1.

4. There can be no doubt that the health of the mussel community near WBN1 is poor and also declining. The data provided in the Mollusk Survey show that freshwater mussel abundance has declined significantly in the area affected by the SCCW since it began cooling Unit 1 in 1999. TVA failed to address three significant trends reflected in this data. First, the abundance of mussels at the three study sites changed significantly between 1996-97 and 2010. In 1996-97, just before the SCCW went into operation for WBN1 in 1998, 344 mussels were collected from the upper bed located just upriver of WBN. That bed now lies within the SCCW discharge plume (p. 40, Revised Aquatics Study). By 2010 the abundance of mussels at the upper bed had been reduced by approximately half to 175 (p. 4, Mollusk Study). This is a major concern, given that the site is within the mixing zone for the SCCW outfall, which had not been in use for a substantial time prior to or during the 1996-97 surveys.

5. The data also show that mussel abundance in both the middle and lower sites increased since 1996-97 (p. 40, Revised Aquatics Study and p. 4, Mollusk Study. These increases may be due to better sampling techniques employed in 2010, or to better reservoir system management practices implemented at Watts Bar Dam. The Discussion of Mollusk Survey does not explain this development. Quite possibly, the SCCW may be thwarting a rebounding mussel population in the vicinity of WBN.
6. Second, the experimental boulder field to provide increased mussel habitat as a mitigation measure for the use of the SCCW had very few mussels – only five -- indicating this action was a failure. TVA's experts attribute this failure to the force of the water flowing from Watts Bar Dam. Baxter and Coutant, par. 70. But they do not acknowledge that the boulder field is located near the SCCW. The death of most relocated mussels, and the substantial decline of mussel numbers in the upper bed show the SCCW has and will continue to have substantial adverse impacts on the mussels near WBN.
7. Finally, the data indicates that a significant number of mussel species are still unable to reproduce and recruit new members to sustain their local populations. The recent survey found the presence of juveniles for four of the 17 species, indicating some reproduction and recruitment is taking place. However, for the other 13 species -- including two endangered species -- no juveniles were present, indicating a lack of reproduction and recruitment capacity, which will lead to eventual local extirpation. In addition, the four reproducing species that were found near WBN1 are just a fraction of the 64 mussel species known to once inhabit the Tennessee River in the vicinity of present day WBN Plant. Thus, only 6% of the indigenous freshwater mussel species remain viable at this time.

8. In paragraph 74 of their affidavit, TVA's experts assert that I erroneously extrapolated TVA's characterization of the Reservoir Benthic Macroinvertebrate Index (RBMI") for the benthic macroinvertebrate community in the SBN vicinity, to the freshwater mussel community specifically. They are incorrect. My opinion is based on a passage in TVA's FSEIS on page 55 which states:

Another aspect of the Vital Signs Monitoring Program is the benthic index, which assesses the quality of benthic communities in the reservoirs (including upstream inflow areas such as that around WBN). The tailwaters of Watts Bar Dam support a variety of benthic organisms *including several large mussel beds*. One of these beds has been documented along the right-descending shoreline immediately downstream from the mouth of Yellow Creek. To protect these beds, the state has established a mussel sanctuary extending 10 miles from TRM 520 to TRM 529.9. Since the institution of the Vital Signs Monitoring Program, the quality of the benthic community in the vicinity of the WBN site has remained relatively constant. The riverine tailwater reach downstream of Watts Bar Dam and WBN rated "good" in 2001 and the rating has increased to "excellent" in 2003-2005 (Appendix C, Tables C-4 and C-5).

(emphasis added). This paragraph specifically discusses freshwater mussels as part of the benthic community evaluated under TVA's Vital Signs Monitoring program. Mussels are benthic macroinvertebrates, and are represented in Metric 2 – "Long-lived Organisms" of the Reservoir Benthic Index (Table 6. Biological Monitoring of the Tennessee River near Watts Bar Nuclear Discharge, 2008). Therefore I did not misinterpret the passage stated in the FSEIS in expressing my opinion that when only four out of 64 (i.e., 6% of) freshwater mussel species once found in the vicinity of WBN remain reproductively viable, in no way can any aspect of the aquatic community be rated in "excellent" health.

9. I do not believe TVA has a reasonable basis for placing the blame for mussel decline solely on river impoundment. While it is clear that river impoundment has severely impacted the mussel community, the results of the 2010 surveys show an alarming decline of mussels in the vicinity of the SCCW. This is evidence that current WBN operations have had a large impact on

mussel health and that adding another reactor unit will increase and perpetuate these negative impacts.

10. Another factor which indicates that the health of macroinvertebrates in general is declining is the dominance of only four species including the Asiatic clam, a non-native, invasive species. As shown in the “Revised Aquatics Study” at page 34, during operational monitoring in 1996-1997, only four of 104 aquatic invertebrate species found made up 87.5%. Further, the average density of aquatic macroinvertebrates per square meter actually declined by more than 50% from 1997 to 2008 in the vicinity of WBN. In 1997, 424 organisms per square meter were reported (Appendix C. Aquatic Ecological Health Determinations for TVA Reservoirs – 1997). In 2008, only 187 organisms per square meter were reported (Table 8. Biological Monitoring of the Tennessee River near Watts Bar Nuclear Discharge, 2008). In 2007 and 2008, even TVA’s Reservoir Benthic Index (RBI) score used to monitor the macroinvertebrate community fell to the “fair” category.

E. RFAI Study and Fish Species Occurrences Study

1. TVA uses Reservoir Fish Assemblage Index (“RFAI”) “scores” to provide general ratings of the fish community within TVA reservoirs. As discussed by TVA’s experts in par. 55, TVA uses the RFAI to determine whether a “Balanced Indigenous Population” is being maintained as required by the EPA under the Clean Water Act. As discussed in Contention 7 and my supporting declaration, I believe TVA’s RFAI scores are biased and misleading, and do not properly reflect the true state of the Tennessee River’s aquatic resources. TVA’s RFAI Study and Fish Species Occurrence Study do not resolve my concerns.

2. In the Fish Species Occurrence Study, TVA analyzed and scored new and historical fish survey data to determine the current presence of fish species, and compared the presence of

species before and after operation of WBN Unit 1. TVA claims that a comparison of scores between 1993 and 2008 shows that both before and after operation of WBN1, TVA has maintained a “balanced indigenous population” (“BPI”). Statement of Material Facts at pp. 14-15. In the RFAI Study, TVA also concludes that “long-term data trends suggest that the ecological health of the fish community in Chickamauga Reservoir inflow has been maintained.” See page 13 of Attachment 9. Furthermore, TVA states that: “The species composition of the fish assemblage of Chickamauga Reservoir has changed somewhat, but not markedly, over the decades of sampling by TVA.” See page 19 of Attachment 10. Neither study remedies my concerns in Contention 7.

3. In my professional opinion, the RFAI and Fish Species Occurrence studies does not present a reliable or reasonably accurate picture of the health of aquatic organisms near WBN1, for several reasons. First, TVA’s method for conducting RFAI studies has changed over the years, making the scores difficult to compare. And the history of the RFAI program indicates that the older scores are unreliable because the methodology for deriving those scores was questioned by EPA and others. In an EPA guidance document, for example, EPA includes improvement of the RFAI in a list of “Research Needs:”

Research Needs -- TVA has been actively developing assessment tools for its reservoirs for several years. The move to a multimetric approach for reservoir fish began in 1990. Successive steps in this development process have brought continued improvement to the RFAI. Potential improvements in the fish indices include using a simple random sampling design rather than a fixed station design to enhance statistical validity with little increase in variability. Use of the index in reservoirs or other river systems is necessary to test its performance under a wider range of conditions than is available in the Tennessee river. Correlation with known human-induced impacts remains a critical need before general acceptance of the fish index as a reliable method to address reservoir environmental quality.

EPA 841-B-98-007 - Lake and Reservoir Bioassessment and Biocriteria: Technical Guidance Document, Appendix D: Biological Assemblages, Section D.5 Fish, pp. 176-177 (Undated).

(<http://water.epa.gov/type/lakes/assessmonitor/bioassessment/upload/lakereservoirbioassess-biocrit-app-d.pdf>) (emphasis added). Second, TVA's summation of data in the Fish Species Occurrence study is biased, and TVA attempts to portray sampling gear changes as the reason for the decline of fish species near WBN and Chickamauga Reservoir in general to mask the reality that the fish community has experienced significant decline pre- and post-WBN operation from cumulative man-made impacts to the aquatic ecosystem.

4. The scientific community has also criticized the RFAI's inability to correlate with environmental degradation or accurately reflect true patterns in environmental health within and among reservoirs:

More recently, a second TVA reservoir version of the IBI [Index of Biotic Integrity] has been developed, termed the Reservoir Fish Assemblage Index (RFAI, Jennings, Karr, and Fore, personal communication). The RFAI has a somewhat different set of 12 metrics (Table 4), with the changes in metrics designed to improve sensitivity to environmental degradation and to increase adaptability to different types of reservoirs. *However, results from applications of both the original TVA version and the newer RFAI have often not accurately reflected what are believed to be the true patterns in environmental health within and among reservoirs*, and additional modifications will probably be necessary to develop better versions of the IBI for impoundments (Jennings, personal communication).

Davis, W. S., and T. S. Simon, Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making, pp. 260-261 (Lewis Publishers: 1995) (emphasis added).

5. However, even the biased RFAI scores declined post-operation, thus undermining TVA's claim that the RFAI scores show that the "good health" of aquatic organisms near WBN1 has not declined. TVA Joint Affidavit, par. 57.

6. Some of the problems with TVA's RFAI methodology can be seen in the 12 metrics described in Paragraph 52 of TVA Joint Affidavit for assessing four general categories of fish health characteristics: Species Richness and Composition, Trophic Composition, Abundance,

and Fish Health. For each metric, scores are given on a scale from 1 to 5, with a score of 5 indicating optimum health.

7. TVA's RFAI scores are predominantly biased by inappropriate assessments of the first category "Species Richness and Composition" and its 8 metrics (i - viii), and the lack of appropriate metrics within the third category "Abundance" (metric xi).

8. Species Richness and Composition – Metric (i) is described as:

- i. Total number of indigenous species: Greater numbers of indigenous species are considered representative of healthier aquatic ecosystems. As conditions degrade, numbers of species at an area decline.

Metric (i) is misleading because it reports only the mere presence of a species, and does not account for its actual abundance, reproductive viability, and future existence within the fish community under evaluation. There is no metric to account for this within the "Abundance" category. A threatened or endangered species would register positively under this metric even though its future existence is doubtful. Several indigenous species were present in only one or two years within a decade sampling period. Again, there is no metric to account for these important trends of indigenous fish decline within the "Abundance" category. Further, the percent of native species is biased by hatchery stockings of species that may otherwise have disappeared from Chickamauga Reservoir.

9. Appendix 1 of Attachment 9 to TVA's Motion illustrates my point. Appendix 1 shows that only one Largescale stoneroller was captured in 2004 and 2008 and zero were captured in all other years from 1999-2009. Yet, these two individuals that were collected during a 10-year sampling period represent species presence in Tables 2 and 3. Similarly, River redhorse (two individuals) and Smallmouth redhorse (one individual), which are Catostomids or suckers, show population trends near WBN similar to the Largescale Stoneroller. Thus, while one or two

individual fish could not reasonably be characterized as a healthy or even viable population, the RFAI considers its presence as a positive attribute. Further, several intolerant species were found during 2009 in the following numbers: Chestnut Lamprey (0), Steelcolor shiner (4), Emerald Shiner (1), Black redhorse (5), Golden redhorse (3), Northern Hogsucker (0). In comparison, several tolerant species were found during 2009 in the following numbers: Bluegill (471), Gizzard shad (131), and Largemouth bass (61). Nevertheless, in 2009, TVA gave this metric a score of 5 (see Attachment 9, p. 144, Appendix 2-A). In my view, given the extremely low abundance of indigenous fish species and the high abundance of tolerant species, this metric should receive a score of 1, or an equivalent metric should be incorporated into the “Abundance” category to properly represent the extremely low abundance of numerous indigenous species.

10. Metric (ii) in the category of “Species Richness and Composition” is described as:

- ii. Number of centrarchid species: Sunfish species (excluding black basses) are invertivores and a high diversity of this group is indicative of reduced siltation and suitable sediment quality in littoral areas.

Metric (ii) yields misleading results because it uses only one of several families of fishes that are commonly used to assess the status of a fish community, and because Centrarchids are not representative of the most vulnerable indigenous fish species. TVA neglected to use other families more representative of the Tennessee River such as Percidae (which includes darters), Catostomidae (i.e., suckers), and Cyprinidae (i.e., minnows). These families were highly diverse and plentiful historically; are intolerant to human disturbance and pollution; and all have suffered severe decline in the Tennessee River. TVA gave this metric a 5, the highest score. The only attribute this reflects is that Centrarchids, which thrive in reservoirs, are well-represented. If one of the other three families were used, this metric would be scored a 1.

11. Metric (iii) in the category of “Species Richness and Composition” is described

as:

iii. Number of benthic invertivore species: Due to the special dietary requirements of this species group and the limitations of their food source in degraded environments, numbers of benthic invertivore species increase with better environmental quality.

As with metric (i), metric (iii) evaluates only the presence of a species, and does not account for its actual abundance, reproductive viability, and future existence in the environment under evaluation. Again, there is no similar metric in the “Abundance” category to measure the actual numbers of a species. If those factors were taken into account, TVA could not have given this metric a score of 3. Given the steep decline of benthic invertivores as described in par. 9, the score should be 1.

12. Metric (iv) in the category of “Species Richness and Composition” is described

as:

iv. Number of intolerant species: This group is made up of species that are particularly intolerant of physical, chemical, and thermal habitat degradation. Higher numbers of intolerant species suggest the presence of fewer environmental stressors. The higher number of these species would be a positive indicator

Metric (iv) should account for status of suckers, minnows, and darters as well as locally endangered or extirpated species such as sturgeon and paddlefish because these fish are intolerant and in decline. As with metrics (i) and (iii), metric (iv) evaluates only the presence of a species, and does not account for its actual abundance, reproductive viability, and future existence in the environment under evaluation. Again, there is no similar metric in the “Abundance” category to measure the actual numbers of a species. If those factors were taken into account, TVA could not have given this metric a score of 5. This metric suffers from the

same bias as Metric (i). TVA gave this metric a score of 5, but it should have received a score of 1.

13. Metric (v) and Metric (vi) in the category of “Species Richness and Composition” are described as:

v. Percentage of tolerant individuals (excluding Young-of-Year): This metric signifies poorer water quality with increasing proportions of individuals tolerant of degraded conditions.

vi. Percent dominance by one species: Ecological quality is considered reduced if one species inordinately dominates the resident fish community.

Metric (v) should identify a fish species community that is dominated by species tolerant of disturbance and poor water quality. Metric (vi) should identify a fish species community that is unbalanced and dominated by only one or few species. These are negative attributes whose scores should be inversely proportional to the degree they exist. TVA’s RFAI sampling shows a high percentage of tolerant species such as bluegills. See par. 19 below. Further, the fish community is currently dominated by bluegills (See par. 19); thus, the score should be a 1. TVA, however, gave Metric (v) a score of 3. TVA correctly gave Metric (vi) a score of 1, which is evidence that the fish community no longer supports a balanced indigenous population.

14. Metric (vii) in the category of “Species Richness and Composition” is described as:

vii. Percentage of non-indigenous species: This metric is based on the assumption that non-indigenous species reduce the quality of resident fish communities.

Like metrics (v) and (vi), this is a negative attribute, whose score should be inversely proportional to the degree it exists. Metric #7 should identify a fish species community that has a significant number of non-indigenous species, i.e. species that are not indigenous to the Tennessee River whether intentionally or unintentionally stocked. TVA sampling shows several

non-indigenous species present; and, that the percent of native species is biased by hatchery stockings of species that may otherwise have disappeared from Chickamauga Reservoir. TVA properly scored this metric with a 1, again indicating that the fish community no longer supports a balanced indigenous population.

15. Metric (viii) in the category of “Species Richness and Composition” is described as:

viii. Number of top carnivore species: Higher diversity of piscivores is indicative of the availability of diverse and plentiful forage species and the presence of suitable habitat.

Metric (viii) should identify a fish species community that is in proper balance with an adequate carnivore population, or fish that eat other fish and serve as the upper food chain predators.

However, this metric may also be biased by hatchery stockings that are used to support a sport fishery. Often hatchery supplementation is used to artificially support a fish population for recreational purposes when the aquatic system no longer supports natural reproduction.

Recreational fisheries often target these predatory fish species such as striped bass, sauger, and walleye, all of which are stocked by the State of Tennessee into Chickamauga Reservoir because of lack of natural reproduction to support fishing. The lack of reproduction is due to the alterations of the Tennessee River and the resulting poor ecological health. While TVA scored this metric at 5, the score should be a 3.

16. The category “Abundance” is as equally important as “Species Richness and Composition”; yet, “Abundance” is only represented by one metric (metric xi) as compared to “Species Richness and Composition” which is represented by eight metrics. This is a major omission that leads to the inappropriately high RFAI scores that overstates the health of the fish community. Metric xi is described as:

xi. Average number per run (number of individuals): This metric is based upon the assumption that high quality fish assemblages support large numbers of individuals.

Metric (xi) is highly biased by the ever-increasing numbers of bluegills and other species that thrive in a man-made environment and now dominate the fish community. The increase of bluegills masks the low number of other native species in decline. TVA, scoring this metric based upon the definition, gave it a 5. However, if this category incorporated similar metrics as “Species Richness and Composition” based upon actual abundance, or number of individuals captured, all of the metrics designed to monitor indigenous fish species would receive RFAI scores of 1, the lowest possible.

17. Paragraph 53 of the Joint Affidavit describes the method for evaluating total RFAI scores as follows:

Because there are 12 metrics, RFAI scores range from 12 to 60. The aquatic community health is indicated by the following ranges of scores: 12-21 (“Very Poor”), 22-31 (“Poor”), 32-40 (“Fair”), 41-50 (“Good”), or 51-60 (“Excellent”).

TVA’s final 2009 RFAI score for the area near WBN Plant was a 44 in the “Good” category. Correcting for the bias of the RFAI would lead to a score of 28, or a “Poor” rating of the health of the fish community. I believe the “poor” rating, which is a significantly different picture of the fish community in the vicinity of WBN than that of TVA’s analyses, more accurately represents the status of the fish community of the Tennessee River in the vicinity of WBN Plant.

18. The score that I estimated is also consistent with other data which show a decrease in the level of diversity and the size of existing populations since WBN1 began operating. For instance, a comparison of the NRC’s 1978 Final Environmental Impact Statement (FEIS) for WBN Units 1 & 2 (Table C-21) and the NRC’s 2008 Final Supplemental Environmental Impact Statement (FSEIS) for WBN Unit 2 (Table 3.3.1) shows that the Chickamauga Reservoir experienced a 24% decline of freshwater fish species between 1970-73 and 1991-1996. Further, Vital Signs and Biological Monitoring reports from 1994 list 36 fish species that were captured

in Upper Chickamauga Reservoir, and reports from 1999-2009 show the number of species declined to between 24 and 31 for a given year, another 14% decline.

19. Evidence that the fish community near WBN is greatly unbalanced may be found by analyzing TVA electrofishing data in Aquatic Ecological Health Determinations for TVA Reservoirs –1994, Table 8, Page 352, and within Biological Monitoring of the Tennessee River Near Watts Bar Nuclear Plant Discharge, 2008, Table 3, Page 18. These data show that in 1994, bluegill -- a species that thrives in man-made habitats and are thus popular for stocking in small ponds across the United States -- comprised only 27% of all fish in TVA's sampling in Upper Chickamauga Reservoir. However, during 2008 sampling, bluegill comprised 63% of all fish captured in Upper Chickamauga Reservoir at areas downstream of Watts Bar Nuclear Plant Discharge. Upon further examination, Centrarchids in general (the family of fishes that is comprised of bluegill, sunfishes, and black-basses) make up 78% of all fish near WBN. A fish community that is made up of 78% bluegill, sunfishes, and black-basses is more indicative of a farm pond than the most biologically diverse freshwater ecosystem in North America. Further, by adding gizzard shad, another species that may thrive in reservoirs, the percent increases to 91%. This results in a very low abundance, whether stated in terms of percent composition and actual numbers, of other native riverine fish species that should be found in the Tennessee River near WBN. When this is compared to 1994 when Centrarchids comprised only 58% and gizzard shad 10%, there is evidence that the fish community is extremely unbalanced, and the percent of indigenous riverine species has continued to decline since WBN1 became operational.

20. Thus, these data show that the fish community has undergone significant negative changes since WBN1 became operational and the current health of the fish community is poor. The data certainly do not support the existence of a Balanced Indigenous Population or "BIP."

F. Failure to Discuss Cumulative Impacts

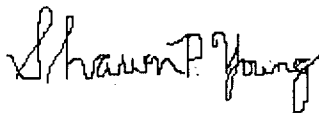
1. TVA has not addressed the cumulative impacts on the Tennessee River Basin from combined operation of WBN Units 1 and 2. The combined operation will increase cooling water needs and increase thermal and chemical discharge. These consequences of adding yet another energy production facility will have adverse impacts on the whole system with large impacts to the upper-basin tributaries that also support highly diverse and unique fish and mussel species. TVA manages the Tennessee River as one hydrosystem; thus, changes in water consumption or changes in flow to accommodate energy and industrial facilities in one area will affect the rest of the system. Further, the quantity of water available at Watts Bar Dam and then released into Chickamauga Reservoir determines the management of the rest of the hydrosystem, especially water releases from the upper basin. Therefore, if WBN Plant requires flow in order to operate at maximum efficiency and to remain within NPDES permit limits, the entire upper basin or at least the aquatic ecology of 10 different tributaries with a high number of fish and mussels will be affected. This is supported by the following excerpts from TVA's discussion of water management policy on its website (<http://www.tva.gov/river/lakeinfo/systemwide.htm>):

- "In May 2004, the TVA Board of Directors approved a new policy for operating the Tennessee River and reservoir system. This policy shifts the focus of TVA reservoir operations from achieving specific summer pool elevations on TVA-managed reservoirs to managing the flow of water through the river system. The new policy specifies flow requirements for individual reservoirs and for the system as a whole."
- "System-wide flow requirements ensure that enough water flows through the river system to meet downstream needs."

- “When water must be released to meet downstream flow requirements, a fair share of water is drawn from each reservoir. System-wide flows are measured at Chickamauga Dam, located near Chattanooga, Tenn., because this location provides the best indication of the flow for the upper half of the Tennessee River system.”
- “If the total volume of water flowing into Chickamauga Reservoir is less than needed to meet system-wide flow requirements, additional water must be released from upstream reservoirs, resulting in some drawdown of these projects. How much water is released depends on the time period and the total volume of water in storage in 10 tributary reservoirs: Blue Ridge, Chatuge, Cherokee, Douglas, Fontana, Nottely, Hiwassee, Norris, South Holston and Watauga.”

2. For all the reasons discussed above, TVA has not resolved the concerns raised by Contention 7. Therefore the contention should not be dismissed.

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.



Shawn Paul Young, Ph.D.
P.O. Box 507
Bonners Ferry, ID 83805

Dated: December 20, 2011

Shawn P. Young, PhD

P.O. Box 507
Bonners Ferry, ID 83805
(765) 427 - 3997
syfishhead@msn.com

EDUCATION

PhD	Fisheries Sciences	May 2005	Clemson University, Clemson, SC
MS	Fisheries Sciences	Aug 2001	Clemson University, Clemson, SC
BS	Environmental Studies	May 1996	Northland College, Ashland, WI

PROFESSIONAL EXPERIENCE

Environmental Consultant	Private practice	Jan 2005 – Present
Fish Biologist	Kootenai Tribe of Idaho	July 2011 - Present
Fisheries Researcher	GADNR/Clemson Univ.	Feb 2010 – Nov 2011
Lecturer/Scientist	University of Idaho	Aug 2008 - Sep 2009
Visiting Scientist	University of Iceland	July 2008 - Aug 2008
Visiting Assistant Professor	Purdue University	Aug 2007- May 2008
Postdoctoral Researcher	Clemson University	Oct 2006 - Aug 2007
Fish Biologist/Facility Manager	Clemson University	Jun 1999 - May 2006
Fisheries Technician	Idaho Fish and Game	Apr 1997 - June 1999

Environmental Consultant - Aquatic Ecology / Fisheries Expert

Private Practice, Owner – Shawn Paul Young LLC Environmental Consulting

- *Savannah Harbor, GA*: Impacts of dredging on Shortnose sturgeon, Atlantic sturgeon, and other native fish
- *Savannah River, GA*: Flow regulation effects on fish in the Savannah River.
- *Wateree River, SC*: River flows and fish habitat - Wateree Dam FERC Re-licensing.
- *Pee Dee River, NC*: River flows and fish habitat - Tillery Dam FERC Re-licensing.
- *Watts Bar Nuclear, TN*: Nuclear reactor impacts to fish and mussel populations - Tennessee River – Chickamauga Reservoir.
- *Bellefonte Nuclear, AL*: Nuclear reactor impacts to fish and mussel populations -Tennessee River – Guntersville Reservoir.
- *Vogtle Nuclear, GA*: Nuclear reactor impacts to fish and mussel populations – Savannah River.
- *North Anna Nuclear, VA*: Nuclear reactor impacts to fish populations – Pamunkey River - North Anna Reservoir
- *Watts Bar NPDES, TN*: Permit comments concerning pollution discharged from operation of nuclear reactors.
- *Tennessee Water Quality Standards*: Comments to strengthen water quality standards and protections during triennial review.

Fish Biologist

Kootenai Tribe of Idaho; Bonners Ferry, ID (July 2011 – Present)

I assist the Kootenai Tribe in all aspects of its Native Fish Program including the aquaculture and restoration of the federally endangered Kootenai River White Sturgeon population. I am one of the technical leads on the design of a new hatchery facility and on the development of a restoration and monitoring strategy for burbot and kokanee. I also represent the Kootenai Tribe on interagency matters including the Kootenai River White Sturgeon Recovery Team and the Kootenai River / Libby Dam Flow Technical Committee. I will also be involved in a large-scale physical habitat restoration effort to restore ecosystem function to a highly altered segment of the Kootenai River in order to rebuild native fish populations.

Fisheries Researcher

Georgia Department of Natural Resources; Albany, GA and Department of Forestry and Natural Resources; Clemson University, Clemson, SC (Feb 2010 – November 2011)

I led a field investigation of spawning Alabama shad in the Apalachicola River, FL. My primary objectives were to estimate spawning population size, to evaluate fish passage at Jim Woodruff Lock and Dam, to determine use of Flint and Chattahoochee Rivers as spawning habitat and juvenile rearing habitat by Alabama shad that passed through the navigation lock, and to determine age, growth, and population structure. I also led the investigation of otolith microchemistry to determine ontogenetic shifts in habitat/anadromy and natal origin, and to determine the role of environmental factors play in recruitment success. My study's ultimate objectives were to halt decline of the Alabama shad and ensure a continued self-sustaining population, with hopes to restore historical abundance.

Researcher – Fisheries Biology and Ecophysiology

University of Idaho; Dept of Fish and Wildlife Resources, Moscow, ID (Dec 2008 – September 2009)

As a member of a research team, I investigated the physiology of wild and hatchery-raised adult Snake River steelhead kelts through life stages from pre-spawn to outmigration to the Pacific Ocean, and the potential to restore wild Snake River steelhead by captive reconditioning of kelts and transport around the Snake/Columbia River hydrosystem.

Lecturer – Fisheries Management

University of Idaho; Department of Fish and Wildlife Resources, Moscow, ID (Fall 2008)

FISH 418 – Fisheries Management w/ Lab

Visiting Scientist

University of Iceland; Reykjavik, Iceland (July 2008)

I was invited by a colleague to investigate physiological differences between genetically distinct components of the Icelandic Atlantic Cod stocks.

Visiting Assistant Professor - Fisheries and Aquatic Sciences

Purdue University; Department of Forestry and Natural Resources; West Lafayette, IN (Aug 2007 – May 2008)

FNR 546 - Fish Ecology

FNR 545 - Fisheries Management

FNR 501 – Limnology

FNR 371 – Watershed Hydrology Practicum

FNR 103 - Introduction to Environmental Conservation

Post-Doctoral Researcher - Adjunct Professor

Dept. of Forestry and Natural Resources: Clemson University, Clemson, SC (Oct 2006 – August 2007)

My research focused on fish ecology and behavior in altered rivers. I conducted research on anadromous and resident fish species in the Apalachicola River. Research objectives were to estimate Alabama shad spawning population size, monitor behavior/movement during spawning migration, and determine passage efficiency at lock-and-dam facilities. I also studied the age, growth, and reproductive ecology of three catostomids and skipjack herring. As another aspect of studying altered river systems, I conducted studies of freshwater mussels to evaluate tagging methods, movement after relocation, and behavior in

fluctuating flow regimes. *(please refer to Publications)*.

Committees:

Age, growth, and fecundity of Alabama shad in the Apalachicola River. Thesis. T. Ingram. 2006.

Population estimate of spawning Alabama shad in the Apalachicola River. Thesis. P. Ely. 2007.

Genotype-specific spawning behavior of striped bass in the Apalachicola River. Thesis. M. Noad. 2007.

Paleochannel delineation of the Neuse River, North Carolina. Thesis. B. Wrege. 2007.

WFB 840 Fish Ecology (Team-taught course)

ENR 302 Natural Resource Measurements (Team-taught course)

WFB 300 Wildlife and Fisheries Biology (Team-taught course)

Research Biologist / Fish – Aquatic Organism Research Facility Manager

Aquatic Animal Research Laboratory; Clemson University, Clemson, SC (June 1999 – May 2006)

I conducted research and managed facilities at a leading fisheries/aquaculture research laboratory. Our research specialized in identifying factors that affect fish and aquatic invertebrate physiology, behavior, and population dynamics. I conducted research on habitat requirements of marine, estuarine, anadromous, and freshwater species at the larval, juvenile, and adult life-history stages. *(Please refer to Publications and Presentations)*. I also assisted with the research and preparation of the following:

- Using mixed-ion supplementation in Pacific white shrimp culture. 2007. Thesis. K. Parmenter.
- Multi-scale habitat associations of selected primary burrowing crayfish. 2006. Dissertation. S. M. Welch.
- Low-salinity resistance of juvenile cobia (*Rachycentron canadum*). 2006. Thesis. K. L. Burkey.
- Responses of Pacific white shrimp (*Litopenaeus vannamei*) to water containing low concentrations of total dissolved solids. 2005. Thesis. A. D. Sowers.
- Responses of hybrid striped bass exposed to waterborne and dietary copper in fresh- and saltwater. 2003. Dissertation. G. K. Bielmyer.
- Ecology and culture of *Procambarus acutus acutus*. 2003. Dissertation. Y. Mazlum.
- Effects of environmental and dietary factors on tolerance of Nile tilapia *Oreochromis niloticus* to low temperature. 2002. Dissertation. H. L. Atwood.
- Low-temperature tolerance of southern flounder *Paralichthys lethostigma*: effect of salinity. 2000. Thesis. W. E. Taylor.

Through the South Carolina Cooperative Fish and Wildlife Research Unit, I also completed a dissertation and thesis that utilized several telemetry field studies to identify seasonal migration patterns, daily movement patterns, and seasonal habitat selection in relation to reservoir limnology/ hydroelectric generation; sources and magnitude of mortality; temporal and spatial patterns of mortality; and, potential to successfully live-release striped bass angled during fishing tournaments. *(Please refer to Publications and Presentations)*. Through graduate coursework, I also acquired extensive knowledge of fisheries science and management; physiology, ecology and conservation of aquatic organisms; limnology and hydrology; and experimental statistics. *(Please see transcripts)*.

Through collaboration with the SC Cooperative Fish and Wildlife Research Unit, I also assisted with the following:

- Reproductive ecology and seasonal migrations of robust redhorse (*Moxostoma robustum*) in the Savannah River, Georgia and South Carolina. 2006. Dissertation. T. B. Grabowski.
- A behavioral comparison of hatchery-reared and wild shortnose sturgeon in the Savannah River, South Carolina-Georgia. 2003. Thesis. D. Trested.

- Diel movement of hatchery-reared and wild shortnose sturgeon in the Savannah River, South Carolina-Georgia. 2003. Thesis. T. E. Griggs.
- Movement of migrating American shad in response to flow near a low head lock and dam. 2003. Thesis. S. T. Finney.
- Population size and movement of American shad at New Savannah Bluff Lock and Dam. 2002. Thesis. M. M. Bailey.
- Seasonal and diel movement of largemouth bass in a South Carolina stream. 2001. Thesis. T. A. Jones.
- Habitat utilization by striped bass in Lake Murray, South Carolina. 2001. Thesis. J. J. Schaffler.

Fisheries Technician

Idaho Dept of Fish & Game; Lewiston & Bonners Ferry, ID (April 1997 - May 1999)

My first appointment was in the Lewiston office where I conducted snorkeling surveys to determine abundance and distribution of anadromous and potadromous salmonids in the Clearwater River Basin.

My second position was in the Bonners Ferry Kootenai River Field station where I assisted research on the effects of hydroelectric operations on behavior and survival of salmonids (rainbow trout and bull trout), burbot, and white sturgeon in the Kootenai River, ID-MT. Major responsibility was to conduct fieldwork for large-scale telemetry and capture studies to acquire knowledge of seasonal movements, migratory behavior, and recruitment.

PUBLICATIONS:

Fish Ecology and Management:

1. **Young, S.P.**, T. I. Ingram, and J. Tannehill. (*in review*). Passage of spawning Alabama shad at Jim Woodruff Lock and Dam, Apalachicola River, Florida. Submittal: Transactions of the American Fisheries Society.
2. **Young, S.P.**, T. I. Ingram, and J. Tannehill. (*in review*). Survival and behavior of transported shoal bass *Micropterus catarractae* in the Flint River, Georgia. Submitted: North American Journal of Fisheries Management.
3. Ingram, T. I., **S. P. Young**, and J. Tannehill. (*in revision*). Age, growth, and fecundity of spawning Alabama shad at Jim Woodruff Lock and Dam, Apalachicola River, Florida. Submittal: Transactions of the American Fisheries Society.
4. **Young, S. P.**, P. Ely, T. Grabowski, and J. J. Isely. (*in review*). Effects of river flow on age, growth, fecundity, and reproductive strategy of catostomids in the Apalachicola River, Florida. Submittal: Environmental Biology of Fishes.
5. **Young, S. P.**, P. Ely, M. Noad, and J. J. Isely. (*in revision*). Age, growth, and relative abundance of skipjack herring in the Apalachicola River, Florida.
6. **Young, S.P.** 2011 Annual Report – Population size, passage, and spawning behavior of Alabama shad, *Alosa alabamiae*, in the Apalachicola River Basin, Florida-Georgia. Prepared for Georgia Department of Natural Resources and National Marine Fisheries Service.
7. **Young, S.P.** 2010 Annual Report – Population size, passage, and spawning behavior of Alabama shad, *Alosa alabamiae*, in the Apalachicola River Basin, Florida-Georgia. Prepared for Georgia Department of Natural Resources and National Marine Fisheries Service.
8. **Young, S.P.**, P. Ely, T. Grabowski, and J. J. Isely. 2010. First Record of *Carpiodes velifer* (highfin carpsucker) in the Apalachicola River, Florida. Southeastern Naturalist 9(1):165-170.
9. Grabowski, T. B., **Young, S. P.**, Libungan, L. A., Steinarsson, A., and G. Marteinsdottir. (2009). Evidence of

phenotypic plasticity and local adaption in metabolic rates between components of the Icelandic cod (*Gadus morhua* L.) stock. *Environmental Biology of Fishes* 86:361-370.

10. Barczak, S., and **S. P. Young**. 2009. Water use impacts from increased energy production on Georgia's aquatic resources. 2009 Georgia Water Resources Conference.
11. Ely, P. and **Young, S. P.**, and J. J. Isely. 2008. Population size and relative abundance of Alabama shad reaching Jim Woodruff Lock and Dam, Apalachicola River, Florida. *North American Journal of Fisheries Management* 28:827-831.
12. **Young, S. P.** and J.J. Isely. 2007. Summer diel behavior of striped bass using tailwater habitat as summer refuge. *Transactions of the American Fisheries Society* 136: 1104-1112.
13. **Young, S. P.**, and J.J. Isely. 2006. Post-tournament live-release survival, dispersal, and behavior of adult striped bass. *North American Journal of Fisheries Management* 26: 1030-1033.
14. **Young, S. P.**, and J.J. Isely. 2004. Temporal and spatial estimates of adult striped bass mortality from telemetry and transmitter return data. *North American Journal of Fisheries Management* 24: 1112-1119.
15. **Young, S. P.** and J.J. Isely. 2002. Striped bass annual site fidelity and habitat utilization in J. Strom Thurmond Reservoir, South Carolina-Georgia. *Transactions of the American Fisheries Society*. 131: 828-837.
16. Isely, J. J., **S. P. Young**, T. A. Jones, and J. J. Schaffler. 2002. Effects of antenna placement and antibiotic treatment on loss of simulated transmitters and mortality in hybrid striped bass. *North American Journal of Fisheries Management*. 22: 204-207.

Fish physiology and aquaculture:

17. Burkey, K. B., **S. P. Young**, J. R. Tomasso, and T. I. J. Smith. 2007. Low-salinity resistance of juvenile cobia. *North American Journal of Aquaculture* 69: 271-274.
18. **Young, S. P.**, J.R. Tomasso, and T.I.J. Smith. 2007. Survival and water balance of black sea bass held in a range of salinities and calcium-enhanced environments after abrupt salinity change. *Aquaculture* 258: 646-649.
19. Atwood, H.L.; **S.P. Young**, J.R. Tomasso, and T.I.J. Smith. 2004. Resistance of cobia, *Rachycentron canadum*, juveniles to low salinity, low temperature, and high environmental nitrite concentrations. *Journal of Applied Aquaculture* 15: 191-195.
20. Atwood, H.L.; **S.P. Young**, J.R. Tomasso, and T.I.J. Smith. 2004. Information on selected water quality characteristics for the production of black sea bass, *Centropristis striata*, juveniles. *Journal of Applied Aquaculture* 15: 183-190.
21. Atwood, H.L.; **S.P. Young**, J.R. Tomasso, and T.I.J. Smith. 2003. Effect of temperature and salinity on survival, growth, and condition of juvenile black sea bass. *Journal of the World Aquaculture Society* 34: 398-402.
22. Atwood, H. L.; **S. P. Young**, J. R. Tomasso, and T.I.J. Smith. 2001. Salinity and temperature tolerances of black sea bass juveniles. *North American Journal of Aquaculture* 63: 285-288.

Aquatic invertebrate conservation:

23. **Young, S. P.** and J. J. Isely. (2008). Tag retention, relocation probability, and mortality of passive integrated transponder and dummy transmitter tagged *Elliptio complanata* in a South Carolina Piedmont stream. *Molluscan Research*.
24. **Young, S. P.** and J. J. Isely. (*in revision*). Behavioral response of the freshwater mussel *Elliptio complanata* to fluctuating water levels. Submittal: *Journal of North American Benthological Society*.
25. **Young, S. P.** and J. J. Isely. (*in progress*). Behavior of translocated freshwater mussels *Elliptio complanata* in a South Carolina piedmont stream.

Aquatic invertebrate physiology and aquaculture:

26. Parmenter, K. and Bisesi, J., **S. P. Young**, S. J. Klaine, H. L. Atwood, J. R. Tomasso, and C. L. Browdy. 2009. Culture of pacific white shrimp *Litopenaeus vannamei* in a variety of mixed- ion solution. North American Journal of Aquaculture 71:134-137.
27. Sowers, A. D. and **Young, S. P.**, M. Grosell, C. L. Browdy , and J. R. Tomasso. 2006. Hemolymph osmolality and cation concentrations in *Litopenaeus vannamei* during exposure to low concentrations of dissolved solids: Relationship to potassium flux. Comparative Biochemistry and Physiology 145(2): 176-180.
28. Sowers, A. D., D. M. Gatlin, **S. P. Young**, J. J. Isely, C. L. Browdy, and J. R. Tomasso. 2005. Responses of *Litopenaeus vannamei* (Boone) in water containing low concentrations of total dissolved solids. Aquaculture Research 36: 819-823.
29. Sowers, A. D. and **Young, S. P.**, J. J. Isely, C. L. Browdy , and J. R. Tomasso. 2004. Nitrite toxicity to *Litopenaeus vannamei* in water containing low concentrations of sea salt or mixed salts. Journal of the World Aquaculture Society 35: 445-451.
30. Atwood, H.L.; **S.P. Young**, J.R. Tomasso, and C. L. Browdy. 2003. Survival and growth of pacific white shrimp, *Litopenaeus vannamei*, postlarvae in low salinity and mixed-salt environments. Journal of the World Aquaculture Society 24: 518-523.

SELECTED PRESENTATIONS:

- Young, S.P.** 2008. Ecophysiology of Iceland's Atlantic cod stocks. University of Idaho. Moscow, ID.
- Young, S.P.** 2007. Thermal biology of fish. Penn State University. State College, PA.
- Young, S.P.** 2007. Population estimates and passage of Alabama shad at Jim Woodruff Lock and Dam, Apalachicola River - Florida. Purdue University. West Lafayette, IN.
- Young, S.P.** 2006. Behavioral thermoregulation and metabolic scope of striped bass in various aquatic environments. Austin Peay University. Clarksville, TN.
- Young, S.P.** 2006. Behavioral thermoregulation and metabolic scope – Lecture for comparative anatomy and physiology. Clemson University. Clemson, SC.
- Young, S.P.** and J.J. Isely. 2005. Post-tournament live-release survival, dispersal, and behavior of adult striped bass. American Fisheries Society annual meeting. Anchorage, AK.
- Young, S.P.** 2005. Behavioral thermoregulation in fish. Lake Superior State University. Sault-sainte Marie, MI.
- Young, S.P.** and J.J. Isely. 2005. Striped bass ecology and management. Clarks Hill Striped Bass Anglers Association. Augusta, GA.
- Young, S.P.** and J.J. Isely. 2005. Post-tournament live-release survival, dispersal, and behavior of adult striped bass. Trout Unlimited. Upstate South Carolina Chapter.
- Young, S.P.** and J.J. Isely. 2004. Temporal and spatial estimates of adult striped bass mortality from telemetry and transmitter return data. Annual meeting of the American Fisheries Society. Madison, WI.
- Atwood, H.L.; **S.P. Young**, J.R. Tomasso, and T.I.J. Smith. 2004. Effect of temperature and salinity on survival, growth, and condition of juvenile black sea bass. 28th Annual Larval Fish Conference, Early Life History Section, American Fisheries Society. Clemson, SC.
- Atwood, H.L.; **S.P. Young**, J.R. Tomasso, and T.I.J. Smith. 2004. Resistance of cobia juveniles to low salinity and low temperature. 28th Annual Larval Fish Conference, Early Life History Section, American Fisheries Society. Clemson, SC.

Young, S.P. 2004. Learning in Fishes: from three-second memory to culture. Department of Biological Sciences. Clemson University.

Young, S.P. 2003. Life skills training for hatchery fish: Social Learning and Survival. Department of Biological Sciences. Clemson University.

Young, S.P. 2003. Mechanisms for learning during early life stages of fish: Imprinting, Homing, and Con-specific Learning. Dept of Biological Sciences. Clemson University.

Young, S.P. 2002. Strain-specific characteristics to manage sub-populations of fish species. Department of Biological Sciences. Clemson University.

AWARDS:

- Animal Research Committee Excellence Award. 2004. Clemson University.
 - Animal Research Committee Excellence Award. 2003. Clemson University.
 - Outstanding Classified Employee Award. 2003. Clemson University.
 - Employee Performance Award. 2003. Clemson University.
-

Docket No. 50-391

**MOTION TO ADMIT NEW CONTENTION REGARDING
THE SAFETY AND ENVIRONMENTAL IMPLICATIONS OF
THE NUCLEAR REGULATORY COMMISSION TASK FORCE REPORT ON
THE FUKUSHIMA DAI-ICHI ACCIDENT**

Pursuant to 10 C.F.R. § 2.309, Southern Alliance for Clean Energy (“SACE”) hereby move to admit a new contention challenging the adequacy of the Final Supplemental Environmental Impact Statement (“FSEIS”) for the proposed Watts Bar Unit 2 Nuclear Power Plant on the basis that it fails to address the extraordinary environmental and safety implications of the findings and recommendations raised by the Nuclear Regulatory Commission’s Fukushima Task Force (the “Task Force”) in its report, “Recommendations for Enhancing Reactor Safety in the 21st Century: The Near-Term Task Force Review of Insights From the Fukushima Dai-ichi Accident” (July 12, 2011) (“Task Force Report”). SACE respectfully submit that admitting the new contention is necessary to ensure that the Nuclear Regulatory Commission (“NRC” or the “Commission”) fulfills its non-discretionary duty under the National Environmental Policy Act (“NEPA”) to consider the new and significant information set forth in the Task Force Report before it makes a decision regarding the Tennessee Valley Authority’s (“TVA’s”) application for an operating license.

This motion is supported by a Certificate Required by 10 C.F.R. § 2.323(b).

II. DISCUSSION

To be admitted for hearing, a new contention must satisfy the six general requirements set forth in 10 C.F.R. § 2.309(f)(1), and the timeliness requirements set forth in either 10 C.F.R. § 2.309(f)(2) (governing timely contentions) or 10 C.F.R. § 2.309(c) (governing non-timely contentions). As provided in the accompanying contention, each of the requirements set forth in 10 C.F.R. § 2.309(f)(1) is satisfied. Furthermore, SACE maintains that this Motion and accompanying contention are timely, and the requirements of 10 C.F.R. § 2.309(f)(2) are also satisfied. In the event this Board determines that this Motion and the accompanying contention are not timely, however, SACE also maintains that the requirements of 10 C.F.R. § 2.309(c) are satisfied.

A. This Motion and the Accompanying Contention Satisfy the Requirements for Admission of a Timely Contention Set Forth in 10 C.F.R. § 2.309(f)(2).

The NRC has adopted a three-part standard for assessing timeliness. *See* 10 C.F.R. § 2.309(f)(2). The Motion and accompanying contention are timely.

1. The Information Upon Which the Motion and Accompanying Contention are Based was not Previously Available.

The availability of material information “is a significant factor in a Board’s determination of whether a motion based on such information is timely filed.” Houston Lighting & Power Co. (South Texas Project, Units 1 & 2), LBP-85-19, 21 NRC 1707, 1723 (1985) (internal citations omitted). This Motion and the accompanying contention are based upon information contained within the Task Force Report, which was not released until July 12, 2011. Before issuance of the Task Force Report, the information material to the contention was simply unavailable.

2. The Information Upon Which the Motion and Accompanying Contention are Based is Materially Different than Information Previously Available.

Only five months ago, a nuclear accident occurred at the Fukushima Dai-ichi Nuclear Power Plant. In the wake of the accident, the Task Force was established and instructed by the NRC to provide:

A systematic and methodical review of [NRC] processes and regulations to determine whether the agency should make additional improvements to its regulatory system and to make recommendations to the Commission for its policy direction, in light of the accident at the Fukushima Dai-ichi Nuclear Power Plant.

Task Force Report at vii. In response to that directive, the Task Force made twelve “overarching” recommendations to “strengthen the regulatory framework for protection against natural disasters, mitigation and emergency preparedness, and to improve the effectiveness of NRC’s programs.” *Id.* at viii. In these recommendations the Task Force, for the first time since the Three Mile Island accident occurred in 1979, fundamentally questioned the adequacy of the current level of safety provided by the NRC’s program for nuclear reactor regulation.

TVA assumes that compliance with existing NRC safety regulations is sufficient to ensure that the environmental impacts of accidents are acceptable. The information in the Task Force Report refutes this assumption and is materially different from the information upon which the ER is based. *See* attached contention and Declaration of Dr. Arjun Makhijani.

3. The Motion and Accompanying Contention are Timely Based on the Availability of the New Information.

SACE has submitted this Motion and accompanying contention in a timely fashion. The NRC customarily recognizes as timely contentions that are submitted within thirty (30) days of the occurrence of the triggering event. Shaw Areva MOX Services, Inc. (Mixed Oxide Fuel Fabrication Facility), LBP-08-10, 67 NRC 460, 493 (2008). The Task Force Report, upon which

the contention is based, was published on July 12, 2001. Because they were filed within thirty (30) days of publication of the Task Force Report, this Motion and accompanying contention are timely.

B. The New Contention Satisfies the Standards For Non-Timely Contentions Set Forth in 10 C.F.R. § 2.309(c).

Pursuant to § 2.309(c), determination on any “nontimely” filing of a contention must be based on a balancing of eight factors, the most important of which is “good cause, if any, for the failure to file on time.” Crow Butte Res., Inc. (North Trend Expansion Project), LBP-08-6, 67 NRC 241 (2008). As set forth below, each of the factors favors admission of the accompanying contention.

1. Good Cause.

Good cause for the late filing is the first, and most important element of 10 C.F.R. § 2.309(c)(1). Private Fuel Storage, L.L.C. (Independent Spent Fuel Storage Installation), CLI-00-02, 51 NRC 77, 79 (2000). Newly arising information has long been recognized as providing the requisite “good cause.” See Consumers Power Co. (Midland Plant, Units 1 & 2), LBP-82-63, 16 NRC 571, 577 (1982), citing Indiana & Michigan Elec. Co. (Donald C. Cook Nuclear Plant, Units 1 & 2), CLI-72-75, 5 AEC 13, 14 (1972). Thus, the NRC has previously found good cause where (1) a contention is based on new information and, therefore, could not have been presented earlier, and (2) the intervenor acted promptly after learning of the new information. Texas Utils. Elec. Co. (Comanche Peak Steam Electric Station, Units 1 & 2), CLI-92-12, 36 NRC 62, 69-73 (1992).

As noted above, the information on which this Motion and accompanying contention are based is taken from the Task Force Report, which was issued on July 12, 2011 and analyzes NRC processes and regulations in light of the Fukushima accident, an event that occurred a mere

five months ago. This Motion and accompanying contention are being submitted less than thirty (30) days after issuance of the Task Force Report.

Accordingly, SACE has good cause to submit this Motion and the accompanying contention now.

2. Nature of SACE's Right to be a Party to the Proceeding.

SACE's right to be a party to this proceeding has been recognized by the Licensing Board in admitting SACE as an intervenor.

3. Nature of SACE's Interest in the Proceeding.

Through submission of this contention, SACE seeks to protect its members' health and safety and the health of the environment in which they live, by ensuring that the NRC fulfills its non-discretionary duty under NEPA to consider the new and significant information set forth in the Task Force Report regarding the potential environmental effects of the operation of Watts Bar Unit 2, before it makes a decision regarding the proposed re-licensing of the plant.

4. Possible Effect of an Order on SACE's Interest in the Proceeding.

SACE's interest in a safe, clean, and healthful environment would be served by the issuance of an order requiring the NRC to fulfill its non-discretionary duty under NEPA to consider new and significant information before making a licensing decision. *See Silva v. Romney*, 473 F.2d 287, 292 1st Cir. 1973). Compliance with NEPA ensures that environmental issues are given full consideration in "the ongoing programs and actions of the Federal Government." *Marsh v. Oregon Natural Res. Council*, 490 U.S. 360, 371 n.14 (1989).

5. Availability of Other Means to Protect SACE's Interests.

With regard to this factor, the question is not whether other parties may protect SACE's interests, but rather whether there are other means by which SACE may protect their own

interests. Long Island Lighting Co. (Jamesport Nuclear Power Station, Units 1 & 2), ALAB-292, 2 NRC 631 (1975). Quite simply, no other means exist. Only through this hearing does SACE have have a right that is judicially enforceable to seek compliance by NRC with NEPA before the NRC makes a decision regarding the proposed issuance of the Watts Bar Unit 2 license.

6. Extent to which SACE's Interests are Represented by Other Parties.

There is no other citizen or environmental organization that has been admitted to the Watts Bar Unit 2 licensing proceeding and therefore no other party can represent its interests.

7. Extent That Participation Will Broaden the Issues.

While SACE's participation may broaden or delay the proceeding, this factor may not be relied upon to deny this Motion or exclude the contention because the NRC has a non-discretionary duty under NEPA to consider new and significant information that arises before it makes its licensing decision. Marsh, 490 U.S. at 373-4.

8. Extent to which SACE Will Assist in the Development of a Sound Record.

SACE will assist in the development of a sound record, as their contention is supported by the expert opinion of a highly qualified expert, Dr. Arjun Makhijani. *See* attached Makhijani Declaration. *See also* Pacific Gas & Elec. Co. (Watts Bar Unit 2 Power Plant Independent Spent Fuel Storage Installation), CLI-08-01, 67 NRC 1, 6 (2008) (finding that, when assisted by experienced counsel and experts, participation of a petitioner may be reasonably expected to contribute to the development of a sound record). Furthermore, as a matter of law, NEPA requires consideration of the new and significant information set forth in the Task Force Report. *See* 10 C.F.R. § 51.92(a)(2). A sound record cannot be developed without such consideration.

C. The New Contention Satisfies the Standards For Admission of Contentions Set Forth in 10 C.F.R. § 2.309(f)(1).

As discussed in the accompanying contention, the standards for admission of a contention set forth in 10 C.F.R. § 2.309(f)(1) are satisfied.

III. CONCLUSION

For the foregoing reasons, this Motion should be granted and the accompanying contention admitted.

Respectfully submitted,

Signed (electronically) by:

Diane Curran

Harmon, Curran, Spielberg & Eisenberg, L.L.P.

1726 M Street N.W. Suite 600

Washington, D.C. 20036

202-328-3500

Fax: 202-328-6918

E-mail: dcurran@harmoncurran.com

August 11, 2011

CERTIFICATE REQUIRED BY 10 C.F.R. § 2.323(b)

I certify that on August 9, 2011, I contacted counsel for TVA and the NRC Staff in an attempt to obtain their consent to this motion. Counsel for TVA stated that TVA objected to the motion and would respond to it. Counsel for the Staff said that the Staff did not object to the filing of the motion but would respond to it with respect to the timeliness and admissibility of the contention.

Electronically signed by

Diane Curran

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

The Task Force, a group of highly qualified and experienced Nuclear Regulatory Commission (“NRC” or the “Commission”) staff members selected by the Commission to evaluate the regulatory implications of the Fukushima Dai-ichi accident, has issued a

report recommending the NRC strengthen its regulatory scheme for protecting public health and safety by increasing the scope of accidents that fall within the “design basis” and are therefore subject to mandatory safety regulation. Recommendations for Enhancing Reactor Safety in the 21st Century: The Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident at 20-21 (July 12, 2011) (“Task Force Report”). The Task Force’s recommendation to establish mandatory safety regulations for severe accidents has extremely grave environmental and safety implications because it would not be logical or necessary to recommend an upgrade to the basic level of protection currently afforded by NRC regulations unless those existing regulations were insufficient to ensure adequate protection of public health, safety, and the environment throughout the licensed life of nuclear reactors. The recommendation is all the more grave because it constitutes the second warning that the Commission has received regarding the need to expand the scope of design basis accidents. The first warning, issued by the Rogovin Report over thirty years ago, following the Three Mile Island accident and explained in more detail in Section II below, essentially went unheeded. *Id.* at 16-17. As the Task Force urges, “the time has come” to make fundamental changes to the NRC’s program for establishing minimum safety requirements for nuclear reactors. *Id.* at 18.

Moreover, the Task Force’s recommendation that the scope of mandatory safety regulations be expanded to include severe accidents raises significant environmental concerns in this proceeding, including that (1) the risks of operating Watts Bar Unit 2 are higher than estimated in the FSEIS and (2) TVA’s previous environmental analysis of the relative costs and benefits of severe accident mitigation alternatives (“SAMAs”) is

fundamentally inadequate because those measures are, in fact, necessary to assure adequate protection of the public health and safety and, therefore, should be imposed without regard to their cost.

Pursuant to the National Environmental Policy Act ("NEPA"), the analysis demanded by this contention may not be deferred until after Watts Bar Unit 2 is licensed. Given that the NRC Commissioners have postponed taking action on the Task Force's recommendations, admission of this contention constitutes the only way of ensuring that the environmental implications of the Task Force recommendations are taken into account in the licensing decision for Watts Bar Unit 2.

SACE wishes to point out that this contention is substantially similar to contentions and comments that are being filed this week in other pending reactor licensing and re-licensing cases and standardized design certification proceedings. In addition, SACE has joined with other individuals and organizations in a rulemaking petition seeking to suspend any regulations that would preclude full consideration of the environmental implications of the Task Force Report. A copy of the rulemaking petition is attached. Finally, in an Emergency Petition, now pending before the Commission for nearly four months, many of the same organizations and individuals previously asked the Commission to suspend its licensing decisions while it evaluated the environmental implications of the Fukushima accident and to establish procedures for the fair and meaningful consideration of those issues in licensing hearings. Emergency Petition to Suspend All Pending Reactor Licensing Decisions and Related Rulemaking Decisions Pending Investigation of Lessons learned From Fukushima Daiichi Nuclear Power Station Accident (April 14-18, 2011) (the "Emergency Petition").

In the aggregate, these contentions, rulemaking comments, and the rulemaking petition follow up on the Emergency Petition's demand that the NRC comply with NEPA by addressing the lessons of the Fukushima accident in its environmental analyses for licensing decisions. Having received no response to their Emergency Petition, the signatories to the Emergency Petition now seek consideration of the Task Force's far-reaching conclusions and recommendations in each individual licensing proceeding, including the instant case.

SACE recognizes that given the sweeping scope of the Task Force conclusions and recommendations, it may be more appropriate for the NRC to consider them in generic rather than site-specific environmental proceedings. That is for the NRC to decide. *Baltimore Gas & Electric Co. v. Natural Resources Defense Council*, 462 U.S. 87, 100 (1983). It is the NRC, and not the public, which is responsible for compliance with NEPA. *Duke Power Co. et al. (Catawba Nuclear Station, Units 1 and 2)*, CLI-83-19, 17 NRC 1041, 1049 (1983).

II. SACE'S NEW CONTENTION SATISFIES THE REQUIREMENTS OF 10 C.F.R. § 2.309 (f)(1).

1. Statement of Contention.

The FSEIS for Watts Bar Unit 2 fails to satisfy the requirements of NEPA because it does not address the new and significant environmental implications of the findings and recommendations raised by the NRC's Fukushima Task Force Report. As required by NEPA and the NRC regulations, these implications must be addressed in the ER.

2. Brief Explanation of the Basis for the Contention.

The Task Force Report.

This contention is based on the Task Force Report, in which the Commission instructed the Task Force to provide:

A systematic and methodical review of [NRC] processes and regulations to determine whether the agency should make additional improvements to its regulatory system and to make recommendations to the Commission for its policy direction, in light of the accident at the Fukushima Dai-ichi Nuclear Power Plant.

Task Force Report at vii. In response to that directive, the Task Force prepared a detailed history of the NRC's program for regulation of safety and public health and evaluated that program in light of the experience of the Fukushima accident.

The Task Force then assessed the risk posed by "continued operation and continued licensing activities" for U.S. nuclear plants. Applying the NRC's standard for whether nuclear plants pose an "imminent risk" such that they should be shut down immediately, *see, e.g., Yankee Atomic Electric Co.* (Yankee Nuclear Power Station), CLI-96-6, 43 NRC 123, 128 (1996) (finding no "imminent hazard" that would warrant shutdown of a reactor), the Task Force found that no imminent risk was posed by operation or licensing. *Id.* at 18. In addition, the Task Force concluded that U.S. reactors meet the statutory standard for security, *i.e.*, they are "not inimical to the common defense and security." *Id.* at 18; *see also* 42 U.S.C. § 2133(d) (forbidding the NRC from licensing reactors if their operation would be "inimical to the common defense and security"). Notably, however, the Task Force did not report a conclusion that licensing of reactors would not be "inimical to public health and safety," as the AEA requires for licensing of reactors. 42 U.S.C. § 2133.

Instead, the Task Force concluded that the regulatory system on which the NRC relies to make the safety findings that the AEA requires for licensing of reactors must be

strengthened by raising the level of safety that is minimally required for the protection of public health and safety:

In response to the Fukushima accident and the insights it brings to light, the Task Force is recommending actions, some general, some specific, that it believes would be a reasonable, well-formulated set of actions *to increase the level of safety associated with adequate protection of the public health and safety.*

Id. at 18 (emphasis added). In particular, the Task Force found that “the NRC’s safety approach is incomplete without a strong program for dealing with the unexpected, including severe accidents.” *Id.* at 20. Therefore, the Task Force recommended that the NRC incorporate severe accidents into the “design basis” and subject it to mandatory safety regulations. In order to upgrade the design basis, the Task Force also recommended that the NRC undertake new safety investigations and impose design changes, equipment upgrades, and improvements to emergency planning and operating procedures. *See, e.g.*, Task Force Report at 73-75.¹

The Task Force also found that the Fukushima accident was not the first warning the NRC had received that it needed to strengthen its safety program in order to provide an adequate level of protection to public health and safety. After the Three Mile Island accident in 1979, an independent body appointed to investigate the accident’s implications, headed by Mitchell Rogovin of the NRC’s Special Inquiry Group, recommended that the NRC “[e]xpand the spectrum of design basis accidents.” *Id.* at 16. But the NRC did little to follow the recommendations of the Rogovin Report. While it “encouraged licensees to search for vulnerabilities” in their plant designs through Individual Plant Examination (“IPE”) and Individual Plant Examination for External

¹ The Task Force Report contains twelve “overarching” recommendations, which are summarized on pages 69-70.

Events (“IPEEE”) programs and encouraged the development of severe accident mitigation guidelines (“SAMGs”), “the Commission did not take action to require the IPEs, IPEEEs, or SAMGs.” *Id.* Thus, the Task Force concluded that:

While the Commission has been partially responsive to recommendations calling for requirements to address beyond-design-basis accidents, the NRC has not made fundamental changes to the regulatory approach for beyond-design-basis events and severe accidents for operating reactors.

Id. at 17. Looking back on the Commission’s failure to heed the Rogovin Report’s recommendations, the Task Force urged that “the time has come” when NRC safety regulations must be “reviewed, evaluated and changed, as necessary, to insure (sic) that they continue to address the NRC’s requirements to provide reasonable assurance of adequate protection of public health and safety.” *Id.* at 18.

To finally fulfill the Rogovin Report’s recommendation, a need now re-confirmed by the Fukushima Task Force, would require a major re-evaluation and overhaul of the NRC’s regulatory program. As the Task Force recognized, the great majority of the NRC’s current regulations do not impose mandatory safety requirements on severe accidents, and severe accident measures are adopted only on a “voluntary” basis or through a “patchwork” of requirements. *Id.*

The lack of an NRC program for mandatory regulation of severe accidents is clearly evident from the regulations themselves. The Part 50 regulations, which establish fundamental safety requirements for all reactors (including the current generation and the proposed new generation), are based on a “design basis” that does not include severe accidents. Task Force Report at 16. While NRC NEPA regulations require consideration of severe accident mitigation measures, they need not be adopted unless they are found to be cost-beneficial. *See, e.g., Entergy Nuclear Operations, Inc.* (Indian Point Nuclear

Generating Station, Units 2 and 3), LBP-11-17, slip op. at 17 (July 14, 2011). Because the imposition of severe accident mitigation measures is based on cost considerations, they are not part of the design basis for adequate protection of public health and safety. *Union of Concerned Scientists v. NRC*, 824 F.2d 108, 120 (D.C. Cir. 1987).²

Therefore, the NRC's current regulatory scheme requires significant re-evaluation and revision in order to expand or upgrade the design basis for reactor safety as recommended by the Task Force Report. The fact that this effort has been postponed for thirty years makes the scope of the required undertaking all the more massive and urgent.

The National Environmental Policy Act.

The contention is also based on NEPA, "our basic national charter for protection of the environment." 40 C.F.R. § 1500.1(a). NEPA requires a federal agency to prepare an Environmental Impact Statement for any "major Federal action significantly affecting the quality of the human environment." 42 U.S.C. § 4332(2)(C)(i). This duty to carefully consider information regarding a project's environmental impacts is non-discretionary. *Silva v. Romney*, 473 F.2d 287, 292 (1st Cir. 1973). Federal agencies are

² Even the NRC's Part 52 regulations for new reactors do not contain mandatory requirements for severe accident mitigation features. While the Part 52 regulations require combined license applicants to submit analyses of measures to mitigate severe accidents, Part 52 contains no standards for the adequacy of such analyses. In addition, the Commission has also stated that Part 52 severe accident mitigation measures, which must be described under the NRC's safety regulations in 10 C.F.R. §§ 52.47(a)(23) and 52.79(a)(38), are subject to cost-benefit analysis. *See, e.g.*, Statement of Considerations ("SOC") for AP1000 design certification rule, 10 C.F.R. Part 52 Appendix B, 71 Fed. Reg. 4,464, 4,469 (January 27, 2006): As stated in that notice:

Westinghouse's evaluation of various design alternatives to prevent and mitigate severe accidents does not constitute design requirements. The Commission's assessment of this information is discussed in Section VII (sic) of this SOC on environmental impacts.

held to a “strict standard of compliance” with the Act’s requirements. *Calvert Cliff’s Coordinating Commission v. AEC*, 449 F.2d 1109, 1112 (D.C. Cir. 1971).

NEPA and the Council on Environmental Quality (“CEQ”) regulations implementing NEPA are intended to ensure that environmental considerations are “infused into the ongoing programs and actions of the Federal Government.” *Marsh v. Oregon Natural Res. Council*, 490 U.S. 360, 371 n.14 (1989). Thus, NEPA imposes on agencies a continuing obligation to gather and evaluate new information relevant to the environmental impact of its actions. *Warm Springs Dam Task Force v. Gribble*, 621 F.2d 1017, 1023-24 (9th Cir. 1980) (citing 42 U.S.C. 4332(2)(A), (B); *Essex County Preservation Ass’n v. Campbell*, 536 F.2d 956, 960-61 (1st Cir. 1976); *Society for Animal Rights, Inc. v. Schlesinger*, 512 F.2d 915, 917-18 (D.C. Cir. 1975)). “An agency that has prepared an EIS cannot simply rest on the original document. The agency must be alert to new information that may alter the results of its original environmental analysis, and continue to take a “hard look” at the environmental effects of [its] planned action, even after a proposal has received initial approval.” *Friends of the Clearwater v. Dombeck*, 222 F.3d 552, 557-58 (9th Cir. 2000) (quoting *Marsh*, 490 U.S. at 373-74).

In order to aid the Commission in complying with NEPA, each applicant shall submit to the Commission an environmental report (“ER”). *See* 10 C.F.R. §§ 51.14; 51.45. In this case, the TVA’s FSEIS serves the same purpose of an ER, *i.e.*, to provide the applicant’s initial analysis of the environmental impacts of the proposed nuclear power plant operation. The ER must contain a description of the proposed action, a statement of its purposes, and a description of the environment affected. *Id.* § 51.45 (b). Further, the ER must discuss the impact of the proposed action on the environment, any

adverse environmental effects which cannot be avoided should the proposal be implemented, alternatives to the proposed action, the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and any reversible and irremediable commitments of resources which would be involved in the proposed action should it be implemented. *Id.* § 51.45(b)(5). The ER must also contain an analysis that considers and balances the environmental effects of the proposed action, the environmental impacts of alternatives to the proposed action, and alternatives available for reducing or avoiding adverse environmental effects. *Id.* § 51.45(c). An environmental report for the licensing action contemplated in this instance must also include consideration of the economic, technical, and other benefits and costs of the proposed action and its alternatives. *Id.* The environmental report must to the fullest extent practicable, quantify the various factors considered and contain sufficient data to aid the Commission in its development of an independent analysis. *Id.*

Within this regulatory framework, “[t]he Commission recognizes *a continuing obligation* to conduct its domestic licensing and related regulatory functions in a manner which is both receptive to environmental concerns and consistent with the Commission’s responsibility as an independent regulatory agency for protecting the radiological health and safety of the public.” *Id.* § 51.10(b) (emphasis added).

The Environmental Report Does Not Consider the Significant New Information Contained in the Task Force Report and the FSEIS Must Be Supplemented to Comply with NEPA.

NEPA requires federal agencies to supplement their NEPA documentation when “there are significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts.” 40 C.F.R. § 1509(c)(1)(ii).

A federal agency's *continuing duty* to take a "hard look" at the environmental effects of their actions requires they consider, evaluate, and make a reasoned determination about the significance of this new information and prepare supplemental NEPA documentation accordingly. *Warm Springs Task Force v. Gribble*, 621 F.2d at 1023-24; *Stop H-3 Association v. Dole*, 740 F.2d 1442, 1463-64 (9th Cir. 1984). The need to supplement under NEPA when there is new and significant information is also found throughout the NRC regulations. *See* 10 C.F.R. §§ 51.92 (a)(2), 51.50(c)(iii), 51.53(b), 51.53(c)(3)(iv).

The conclusions and recommendations presented in the Task Force Report constitute "new and significant information" whose environmental implications must be considered before the NRC may make a decision that approves the licensing of Watts Bar Unit 2. First, the information is "new" because it stems directly from the Fukushima accident, which occurred only five months ago and for which the special study commissioned by the Commission has only just been issued.

Second, the information is "significant" because it raises an extraordinary level of concern regarding the manner in which the proposed operation of Watts Bar Unit 2 "impacts public health and safety." *See* 40 C.F.R. § 1508.27(b)(2). For the first time since the Three Mile Island accident occurred in 1979, a highly respected group of scientists and engineers within the NRC Staff has fundamentally questioned the adequacy of the current level of safety provided by the NRC's program for nuclear reactor regulation. NEPA demands that federal agencies "insure the professional integrity, including the scientific integrity, of the discussions and analyses" included in an EIS³ and disclose "all major points of view on the environmental impacts" including any

³ 40 C.F.R. § 1502.24.

“responsible opposing view.”⁴ Courts have found that an EIS that fails to disclose and respond to expert opinions concerning the hazards of a proposed action, particularly those opinions of the agency’s own experts, are “fatally deficient” and run contrary to NEPA’s “hard look” requirement.⁵ As a result, the NRC must revisit any conclusions in the FSEIS for Watts Bar Unit 2 which is based on the assumption that compliance with NRC safety regulations is sufficient to ensure that environmental impacts of accidents are acceptable.

The Task Force Report Reveals that the Full Spectrum of All Design-Basis Accidents Has Not Been Assessed and the FSEIS Must Be Supplemented to Consider Additional Design-Basis Accidents that Have the Potential for Releases to the Environment.

In Section 3.12.1 of the FSEIS, TVA asserts that:

The term “accident” refers to any unintentional event (i.e., outside the normal or expected plant operation envelope) that results in a release or a potential for a release of radioactive material to the environment. The NRC categorizes accidents as either design basis or severe. Design basis accidents are those for which the risk is great enough that NRC requires the plant design and construction to prevent unacceptable accident consequences. Severe accidents are those that NRC considers too unlikely to warrant normal design controls.

⁴ 40 C.F.R. §§ 1502.9(a), (b)

⁵ *Center for Biological Diversity v. United States Forest Service*, 349 F.3d 1157 (9th Cir. 2003) (finding an EIS’s failure to disclose and discuss responsible opposing scientific viewpoints violated NEPA and the implementing regulations); *Seattle Audubon Society v. Moseley*, 798 F.Supp. 1473, 1479 (W.D. Wa. 1992) aff’d sub nom *Seattle Audubon Society v. Espy*, 998 F.2d 699 (9th Cir. 1993) (quoting *Friends of the Earth v. Hall*, 693 F.Supp. 904, 934 (W.D. Wa. 1988) (“[a]n EIS that fails to disclose and respond to ‘the opinions held by well respected scientists concerning the hazards of the proposed action...is fatally deficient.’”)); *Western Watersheds Project v. Kraayenbrink*, 632 F.3d 472, 487 (9th Cir. 2010) (finding that agency failed to take a “hard look” under NEPA when it ignored concerns raised by its own experts). See also *Blue Mtns. Biodiversity Project v. Blackwood*, 161 F.3d 1208, 1213 (9th Cir. 1998) (noting that an agency’s failure to discuss and consider an independent scientific report’s recommendations “lends weight to [plaintiff’s] claim that the [agency] did not take the requisite ‘hard look’ at the environmental consequences” of the project).

FSEIS at 73. Thus, TVA bases its environmental analysis on the assumption that compliance with the NRC's regulatory program for protection against design basis accidents is sufficient to maintain environmental impacts from design basis accidents at an acceptable or insignificant level, and that severe accidents are too unlikely to merit inclusion in the design basis. The findings of the Task Force Report call these assumptions into serious question. *See* Makhijani Declaration, pars. 7-10. If, as suggested by the Task Force Report, the design basis for the reactor does not incorporate accidents that should be considered in order to satisfy the adequate protection standard, then it is not possible to reach a conclusion that the design of the reactor adequately protects against accident risks.

The FEIS Must Be Supplemented in Light of the Task Force Findings that Certain Accidents Formerly Classified as Severe Should Be Incorporated into the Design Basis.

By recommending the incorporation of accidents formerly classified as "severe" or "beyond design basis" into the design basis, the Task Force effectively recommends a complete overhaul of the NRC's system for mitigating severe accidents through consideration of SAMAs. *See* 10 C.F.R. § 51.45(c). As the Task Force recognizes, currently the NRC does not impose measures for the mitigation of severe accidents unless they are shown to be cost-beneficial or unless they are adopted voluntarily. Task Force Report at 15. *See also* 10 C.F.R. §§ 51.71(d); 51.75(c)(2) (allowing EISs for combined license applications ("COLAs") that rely on certified standardized designs to reference the severe accident mitigation analyses for those designs).⁶ But the Task Force

⁶ *See also* Memorandum from NRC Staff to AP1000 and ESBWR design-Centered Working Groups re: Summary of the March 22 and 23, 2007, Meeting to Discuss pre-Combined License Application Issues (April 23, 2007) (suggesting that some SAMAs for

recommends that severe accident mitigation measures should be adopted into the design basis, *i.e.*, the set of regulations adopted *without regard to their cost* as fundamentally required for all NRC standards that set requirements for adequate protection of health and safety. *Union of Concerned Scientists v. NRC*, 824 F.2d 108, 120 (D.C. Cir. 1987).

Thus, the values assigned to the cost-benefit analysis for Watts Bar Unit 2, as described in TVA's SAMA analysis (*see* Memorandum to File from Robert Lutz, Westinghouse, re: Watts Bar Unit 2 Severe Accident Mitigation Analysis (January 29, 2009)), must be re-evaluated in light of the Task Force's conclusion that the value of SAMAs is so high that they should be elected as a matter of course.

Were SAMAs imposed as mandatory measures, the outcome of the FSEIS and subsequently the NRC's EIS for Watts Bar Unit 2 could be affected significantly in two major respects. First, severe accident mitigative measures now rejected as too costly may be required, thus substantially improving the safety of the Watts Bar Unit 2 operation if it is licensed. Second, consideration of the costs of mandatory mitigative measures could affect the overall cost-benefit analysis for the reactor.⁷ As discussed in Dr. Makhijani's declaration, these costs may be significant, showing that other alternatives such as the no-action alternative and other alternative electricity production sources may be more attractive.⁸ As the fundamental purposes of NEPA are: (1) to guarantee that the

proposed reactors with standardized designs should be included in the design application and some should be included in COLAs).

⁷ See 10 C.F.R. § 51.45 (c) (explaining that environmental reports should also include consideration of the economic, technical, and other benefits and costs of the proposed action and its alternatives).

⁸ NEPA requires the NRC to include in its EIS a "detailed statement . . . on . . . alternatives to the proposed action." 42 U.S.C. § 4332(C)(iii). The alternatives analysis should address "the environmental impacts of the proposal and the alternatives in comparative form, thus sharply defining the issues and providing a clear basis for the

government takes a “hard look” at all of the environmental consequences of proposed federal actions before the actions occur, *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 350 (1989); and (2) to “guarantee[] that the relevant information will be made available to the larger audience that may also play a role in both the decisionmaking process and the implementation of that decision,” *id.* at 349, the NRC cannot meet the fundamental purposes of NEPA if it does not include all of the costs associated with required mitigative measures. *See Sierra Club v. Sigler*, 695 F.2d 957, 979 (5th Cir. 1983) (“There can be no ‘hard look’ at the costs and benefits unless all costs are disclosed.”).

The FSEIS Must Be Supplemented to Include a Discussion of the Task Force Report’s Recommended Measures to Ensure the Plant’s Protection From Seismic and Flooding Events.

Following the devastating events in Japan, the Task Force Report explained the importance of protecting structures, systems and components (SSCs) of nuclear reactors from natural phenomena, including seismic and flooding hazards:

Protection from natural phenomena such seismic and flooding is critical for safe operation of nuclear power plants due to potential common-cause failures and significant contribution to core damage frequency from external events. Failure to adequately protect SSC’s important to safety from appropriate design-basis natural phenomena with appropriate safety margins has the potential for common-

choice among options by the decisionmaker and the public.” 40 C.F.R. § 1502.14. This analysis must “rigorously explore and objectively evaluate all reasonable alternatives.” 40 C.F.R. § 1502.14(a). Agencies must consider three types of alternatives, which include a no action alternative, other reasonable courses of actions, and mitigation measures not in the proposed action. 40 C.F.R. § 1508.25. The purpose of this section is “to insist that no major federal project should be undertaken without intense consideration of other more ecologically sound courses of action, including shelving the entire project, or of accomplishing the same result by entirely different means.” *Environmental Defense Fund v. Corps of Engineers*, 492 F.2d 1123, 1135 (5th Cir. 1974). “The existence of a viable but unexamined alternative renders an [EIS] inadequate.” *Natural Resources Defense Council v. U.S. Forest Service*, 421 F.3d 797, 813 (9th Cir. 2005) (quoting *Citizens for a Better Henderson v. Hodel*, 768 F.2d 1051, 1057 (9th Cir. 1985)).

cause failures and significant consequences as demonstrated at Fukushima. Task Force Report at 30.

Yet, the Task Force found that significant differences may exist between plants in the way they protect against design-basis natural phenomena (including seismic and flooding hazards) and the safety margin provided. Task Force Report at 29. For instance, while tsunami hazards have been considered in the design basis for operating plants sited on the Pacific Ocean, the same cannot be said for those sited on the Atlantic Ocean and Gulf of Mexico. *Id.* Accordingly, the Task Force recommended that licensees reevaluate the seismic and flooding hazards at their sites and if necessary update the design basis and SSCs important to safety to protect against the updated hazards. Task Force Report at 30.

The FSEIS must be supplemented in light of this new and significant information. The Task Force's findings and recommendations are directly relevant to environmental concerns and have a bearing on the proposed action and its impacts as they point to the need for a reevaluation of the seismic and flooding hazards at the Watts Bar Unit 2 site, a "hard look" at the environmental consequences such hazards could pose, and an examination of what, if any, design measures could be implemented (i.e. through NEPA's requisite "alternatives" analysis) to ensure that the public is adequately protected from these risks.

The FSEIS Must Be Supplemented to Include a Discussion of the Additional Mitigation Measures Recommended by the Task Force Report.

"The discussion of steps that can be taken to mitigate adverse environmental consequences plays an important role in the environmental analysis under NEPA."

Robertson v. Methow Valley Citizens Council, 490 U.S. 332, 351 (1989); *see also*

1502.16(h) (stating that an EIS must contain “means to mitigate adverse environmental impacts”). There must be a “reasonably complete discussion of possible mitigation measures.” *Robertson*, 490 U.S. at 352. Mitigation measures may be found insufficient when the agency fails to study the efficacy of the proposed mitigation, fails to take certain steps to ensure the efficacy of the proposed mitigation (such as including mandatory conditions in permits), or fails to consider alternatives in the event that the mitigation measures fail. *Id.*

The Task Force Report makes several significant findings when it comes to increasing and improving mitigation measures at new reactors and recommends a number of specific steps licensees could take in this regard. These recommendations include strengthening SBO mitigation capability at all operating and new reactors for design-basis and beyond-design-basis external events, (Section 4.2.1), requiring reliable hardened vent designs in BWR facilities with Mark I and Mark II containments (Section 4.2.2), enhancing spent fuel pool makeup capability and instrumentation for the spent fuel pool (Section 4.2.4), strengthening and integrating onsite emergency response capabilities such as EOPs, SAMGs, and EDMGs (Section 4.2.5) and addressing multi-unit accidents. *See also* Makhijani Declaration, pars. 18-24. Accordingly, the FSEIS must be supplemented to consider the use of these additional mitigation measures to reduce the project’s environmental impacts. *See* 40 C.F.R. §§ 1502.14(f), 1502.16), 1508.25 (b)(3)).

Requirement for Prior Consideration of Environmental Impacts.

The Task Force urges that some of its recommendations be considered before certain licensing decisions are made. For instance, the Task Force recommends that the

operating license review for Watts Bar Unit 2 should include “all of the near-term actions and any of the recommended rule changes that have been completed at the time of licensing.” Task Force Report at 72. Similarly, the Task Force recommends that Recommendation 4 (proposing new requirements for prolonged station blackout (“SBO”) mitigation) and Recommendation 7 (proposing measures for spent fuel pool makeup capability and instrumentation) should apply to all design certifications or to COL applicants if the recommended requirements are not addressed in the referenced certified design. Task Force Report at 71. The Task Force recommends that design certifications and COLs under active staff review address this recommendation “before licensing.” *Id.* at 72.

SACE respectfully submits that NEPA does not give the NRC the discretion to postpone consideration of any of the Task Force recommendations until after the licensing of Watts Bar or any other reactor for which a licensing decision is before the agency. NEPA requires the NRC to address the environmental implications of the Task Force’s analysis *before* making a re-licensing decision for Watts Bar Unit 2, in order to ensure that “important effects [of the licensing decision] will not be overlooked or underestimated only to be discovered after resources have been committed or the die otherwise cast.” *Robertson*, 490 U.S. at 349. *See also* 40 C.F.R. §§ 1500.1(c), 1502.1, 1502.14. The NRC’s obligation to comply with NEPA in this respect is independent of and in addition to the NRC’s responsibilities under the AEA, and must be enforced to the “fullest extent possible.” *Calvert Cliffs Coordinating Committee*, 449 F.2d at 1115. *See also Limerick Ecology Action v. NRC*, 869 F.2d 719, 729 (3rd Cir. 1989) (citing *Public Service Co. of New Hampshire v. NRC*, 582 F.2d 77, 86 (1st Cir. 1978)). Under NEPA,

therefore, the Commission is required to address the Task Force's findings and recommendations as they pertain to Watts Bar Unit 2 before making a licensing decision, regardless of whether it does or does not choose to do so in the context of its AEA-based regulations.

Of course the Commission could moot the contention by adopting all of the Task Force's recommendations. See *Citizens for Safe Power v. NRC*, 524 F.2d 1291, 1299 (D.C. Cir. 1975). However, a majority of the Commissioners has voted not to do so immediately. See Notation Vote Response Sheets re: SECY-11-0093, Near-Term Report and Recommendations for Agency Actions Following the Events in Japan, posted on the NRC's website at <http://www.nrc.gov/reading-rm/doc-collections/commission/cvr/2011/>. Thus, while the NRC may eventually address the Task Force's recommendations in the context of its AEA-based regulatory scheme, the Commission has given no indication that it intends to address any of the Task Force's conclusions in its prospective licensing decisions. In the absence of any AEA-based review of the Task Force's conclusions, the FSEIS for Watts Bar Unit 2 must be supplemented in order to meet NEPA's goal that the NRC's licensing decision for Watts Bar Unit 2 will be "based on an accurate understanding of the environmental consequences of [its] actions." *Indian Point*, LBP-11-17, slip op. at 17.

3. Demonstration that the Contention is Within the Scope of the Proceeding.

The contention is within the scope of the proceeding because it seeks compliance with NEPA and NRC-implementing regulations, which must be complied with before Watts Bar Unit 2 may be licensed.

4. Demonstration that the Contention is Material to the Findings NRC Must Make to License Watts Bar Unit 2.

As demonstrated above in Section B, this contention challenges TVA's failure to fully comply with NEPA and federal regulations for the implementation of NEPA in its FSEIS for the proposed licensing of Watts Bar Unit 2. TVA's FSEIS is akin to an environmental report and therefore it must comply with NEPA supplementation requirements in the same way that ERs prepared by applicants or environmental impact statements prepared by the NRC must comply. Unless TVA and the NRC comply with the procedural requirements of NEPA that are discussed in the contention, the NRC cannot make a valid finding that Watts Bar Unit 2 should be licensed. Therefore the contention is material to the findings the NRC must make in order to license this facility.

SACE recognizes that some issues raised by the Task Force Report may be appropriate for generic rather than case-specific resolution. The determination of whether it is appropriate to address the issues raised in this contention generically or on a case-specific basis is a discretionary matter for the NRC to decide. *Baltimore Gas & Electric Co. v. Natural Resources Defense Council*, 462 U.S. at 100. Nevertheless, any generic resolution of the issues must be reached *before* the licensing decision in this case is made, and must be applied to this licensing decision. *Robertson*, 490 U.S. at 350.

5. Concise Statement of the Facts or Expert Opinion Supporting the Contention, Along With Appropriate Citations to Supporting Scientific or Factual Materials.

SACE relies on the facts and opinions of the Task Force members as set forth in their Task Force Report and as summarized above in Section B. The high level of technical qualifications of the Task Force members has been recognized by the

Commission. *See* Transcript of May 12, 2011, briefing at 5, in which Commissioner Magwood refers to the Task force as the NRC's "A-team."

Additional technical support is provided by the attached Declaration of Dr. Arjun Makhijani, which confirms the environmental significance of the Task Force's findings and recommendations with respect to the environmental analyses for all pending nuclear reactor licensing cases and design certification applications including the instant case.

6. Sufficient Information to Show the Existence of a Genuine Dispute With the Applicant and the NRC.

Based on the complete failure of the NRC to address the environmental implications of the Task Force Report for the proposed licensing of Watts Bar Unit 2, it appears that the parties have a dispute as to whether the FSEIS for the facility must be revised to address those implications. As demonstrated above in Section B, the Task Force Report and Dr. Makhijani's Declaration provide sufficient information to show the genuineness and materiality of the dispute.

III. CONCLUSION

For the foregoing reasons, the contention is admissible and should be admitted for a hearing.

Respectfully submitted,

Signed (electronically) by:

Diane Curran
Harmon, Curran, Spielberg & Eisenberg, L.L.P.
1726 M Street N.W. Suite 600
Washington, D.C. 20036
202-328-3500
Fax: 202-328-6918
E-mail: dcurran@harmoncurran.com

August 11, 2011

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
BEFORE THE ATOMIC SAFETY AND LICENSING BOARD
AND THE SECRETARY

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

**RULEMAKING PETITION TO RESCIND PROHIBITION
AGAINST CONSIDERATION OF ENVIRONMENTAL IMPACTS
OF SEVERE REACTOR AND SPENT FUEL POOL ACCIDENTS
AND REQUEST TO SUSPEND LICENSING DECISION**

I. INTRODUCTION

Pursuant to 10 C.F.R. § 2.802, Southern Alliance for Clean Energy (“SACE”) petitions the U.S. Nuclear Regulatory Commission (“NRC”) to rescind regulations in 10 C.F.R. Part 51 that make generic conclusions about the environmental impacts of severe reactor and spent fuel pool accidents and that preclude consideration of those issues in individual licensing proceedings. This petition also requests the NRC to suspend the above-captioned licensing proceeding while the NRC considers this petition and the environmental issues raised in the attached Contention Regarding NEPA Requirement to Address Safety and Environmental Implications of the Fukushima Task Force Report (“Contention”).

This petition is captioned in both the rulemaking docket and the docket for the Watts Bar Unit 2 licensing proceeding because it seeks relief that is both generic and applicable to the individual proceeding. The rulemaking petition is also being filed by other organizations and individuals who have submitted contentions regarding the safety

and environmental implications of the NRC's report entitled Recommendations for Enhancing Reactor Safety in the 21st Century: The Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident at 20-21 (July 12, 2011) ("Task Force Report").

II. DISCUSSION

A. General Solution

The general solution sought by SACE is to rescind all regulations in 10 C.F.R. Part 51 to the extent that they reach generic conclusions about the environmental impacts of severe reactor and/or spent fuel pool accidents and therefore prohibit consideration of those impacts in reactor licensing proceedings. These regulations include 10 C.F.R. Part 51, Appendix B; 10 C.F.R. §§ 51.45, 51.53, and 51.95.

B. SACE's Grounds for and Interest in the Action Requested.

SACE seeks rescission of any NRC regulations that would prevent the NRC from complying with its obligation under the National Environmental Policy Act ("NEPA") and NRC implementing regulations to consider, in the operating license proceeding for Watts Bar Unit 2, the environmental implications of new and significant information discussed in the Task Force Report regarding the regulatory implications of the Fukushima Dai-ichi nuclear accident. Our legal and technical grounds for seeking consideration of new and significant information in the Task Force Report are discussed at length in the attached Contention, which is attached and incorporated herein by reference.

C. Support for Petition

This petition for rulemaking is supported by the Task Force Report and also by the attached Declaration of Dr. Arjun Makhijani (August 8, 2011). As demonstrated in both of those documents, the Fukushima accident has significant regulatory implications with respect to both severe reactor accidents and spent fuel pool accidents, because the Task Force Report recommends that mitigative measures for both of these types of accidents, which are not currently included in the design basis for nuclear reactors, should be added to the design basis and subject to mandatory safety regulation.

D. Request for Suspension of Licensing Proceeding

As discussed in the attached Contention, NEPA requires that agencies consider the environmental impacts of their actions *before* they are taken, in order to ensure that “important effects [of the licensing decision] will not be overlooked or underestimated only to be discovered after resources have been committed or the die otherwise cast.” *Robertson*, 490 U.S. 332, 349 (1989). *See also* 40 C.F.R. §§ 1500.1(c), 1502.1, 1502.14. The NRC’s obligation to comply with NEPA in this respect is independent of and in addition to the NRC’s responsibilities under the Atomic Energy Act, and must be enforced to the “fullest extent possible.” *Calvert Cliffs Coordinating Committee*, 449 F.2d at 1115. *See also Limerick Ecology Action v. NRC*, 869 F.2d 719, 729 (3rd Cir. 1989) (citing *Public Service Co. of New Hampshire v. NRC*, 582 F.2d 77, 86 (1st Cir. 1978)). The NRC’s obligation to delay licensing decisions until after it has considered the environmental impacts of those decisions is also nondiscretionary. *Silva v. Romney*, 473 F.2d 287, 292 (1st Cir. 1973). Therefore the NRC has a non-discretionary duty to suspend the Watts Bar Unit 2 operating license proceeding while it considers the

environmental impacts of that decision, including the environmental implications of the Task Force Report with respect to severe reactor and spent fuel pool accidents.

III. CONCLUSION

For the foregoing reasons, the Commission should grant this rulemaking petition.

Respectfully submitted,

Signed (electronically) by:

Diane Curran

Harmon, Curran, Spielberg & Eisenberg, L.L.P.

1726 M Street N.W. Suite 600

Washington, D.C. 20036

202-328-3500

Fax: 202-328-6918

E-mail: dcurran@harmoncurran.com

August 11, 2011



**INSTITUTE FOR ENERGY AND
ENVIRONMENTAL RESEARCH**

6935 Laurel Avenue, Suite 201
Takoma Park, MD 20912

Phone: (301) 270-5500
FAX: (301) 270-3029
e-mail: ieer@ieer.org
<http://www.ieer.org>

**DECLARATION OF DR. ARJUN MAKHIJANI
REGARDING SAFETY AND ENVIRONMENTAL SIGNIFICANCE OF
NRC TASK FORCE REPORT REGARDING LESSONS LEARNED FROM
FUKUSHIMA DAIICHI NUCLEAR POWER STATION ACCIDENT¹**

I, Arjun Makhijani, declare as follows:

Introduction and Statement of Qualifications

1. I am President of the Institute for Energy and Environmental Research ("IEER") in Takoma Park, Maryland. Under my direction, IEER produces technical studies on a wide range of energy and environmental issues to provide advocacy groups and policy makers with sound scientific information and analyses as applied to environmental and health protection and for the purpose of promoting the understanding and democratization of science. A copy of my curriculum vita is attached.
2. I am qualified by training and experience as an expert in the fields of plasma physics, electrical engineering, nuclear engineering, the health effects of radiation, radioactive waste management and disposal (including spent fuel), estimation of source terms from nuclear facilities, risk assessment, energy-related technology and policy issues, and the relative costs and benefits of nuclear energy and other energy sources. I am the principal author of a report on the 1959 accident at the Sodium Reactor Experiment facility near Simi Valley in California, prepared as an expert report for litigation involving radioactivity emissions from that site. I am also the principal author of a book, *The Nuclear Power Deception: U.S. Nuclear Mythology from Electricity "Too Cheap to Meter" to "Inherently Safe" Reactors* (Apex Press, New York, 1999, co-author, Scott Saleska), which examines, among other things, the safety of various designs of nuclear reactors.
3. I have written or co-written a number of other books, reports, and publications analyzing the safety, economics, and efficiency of various energy sources, including nuclear power. I am also the author of *Securing the Energy Future of the United States: Oil, Nuclear and Electricity*

¹ Task Force Review (*Recommendations for Enhancing Reactor Safety in the 21st Century: The Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident*, Nuclear Regulatory Commission, July 12, 2011, at <http://pbadupws.nrc.gov/docs/ML1118/ML111861807.pdf>)

Vulnerabilities and a Post-September 11, 2001 Roadmap for Action (Institute for Energy and Environmental Research, Takoma Park, Maryland, December 2001). In 2004, I wrote "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 at 61-72 (2004). The article was adapted from an oral presentation given on April 18, 2003, at the Eighth Annual Wallace Stegner Center Symposium entitled, "Nuclear West: Legacy and Future," held at the University of Utah S.J. Quinney College of Law. In 2008, I prepared a report for the Sustainable Energy & Economic Development (SEED) Coalition entitled *Assessing Nuclear Plant Capital Costs for the Two Proposed NRG Reactors at the South Texas Project Site*.

4. I am generally familiar with the basic design and operation of U.S. nuclear reactors and with the safety and environmental risks they pose. I am also generally familiar with materials from the press, the Japanese government, the Tokyo Electric Power Company, the French government safety authorities, and the U.S. Nuclear Regulatory Commission ("NRC") regarding the Fukushima Daiichi (hereafter Fukushima) accident and its potential implications for the safety and environmental protection of U.S. reactors. I have also read *Recommendations for Enhancing Reactor Safety in the 21st Century: The Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident*, July 12, 2011 (hereafter the "Task Force Review"), published by the NRC.

5. On April 19, 2011, I prepared a declaration stating my opinion that although the causes, evolution, and consequences of the Fukushima accident were not yet fully clear a month after the accident began, it was already presenting new and significant information regarding the risks to public health and safety and the environment posed by the operation of nuclear reactors. My declaration was submitted to the NRC by numerous individuals and environmental organizations in support of a legal petition to suspend licensing decisions while the NRC investigated the regulatory implications of the Fukushima accident. Emergency Petition to Suspend All Pending Reactor Licensing Decisions and Related Rulemaking Decisions Pending Investigation of Lessons learned From Fukushima Daiichi Nuclear Power Station Accident (April 14-18, 2011). In my declaration I also stated my belief that the integration of new information from the Fukushima accident into the NRC's licensing process could affect the outcome of safety and environmental analyses for reactor licensing and relicensing decisions by resulting in the denial of licenses or license extensions or the imposition of new conditions and/or new regulatory requirements. I also expressed the opinion that the new information could also affect the NRC's evaluation of the fitness of new reactor designs for certification. *Id.*, par. 5.

Purpose

6. The purpose of my declaration is to explain why the Task Force Review provides further support for my opinions that the Fukushima accident presents new and significant information regarding the risks to public health and safety and the environment posed by the operation of nuclear reactors and that the integration of this new information into the NRC's licensing process could affect the outcome of safety and environmental analyses for reactor licensing and relicensing decisions and the NRC's evaluation of the fitness of new reactor designs for certification.

Agreement With Task Force Review's Conclusions Regarding Need to Expand Design Basis

7. In my opinion, the Task Force reasonably concludes that substantial revisions to the very framework of NRC regulations are needed to adequately protect public health and the environment. I also agree that a major overarching step that needs to be taken is to integrate into the design basis for NRC safety requirements an expanded list of severe accidents and events, based on current scientific understanding and evaluations. This would ensure that potential mitigation measures are evaluated on the basis of whether they are needed for safety and not whether they are merely desirable. Should the NRC fail to incorporate an expanded list of severe accident requirements in the design basis of reactors, then a conclusion that the design provides for adequate protection to the public against severe accident risks could not be justified. The necessity for an expanded list of design basis requirements should be viewed in light of the Fukushima experience and the nuclear accident experience which preceded Fukushima, including Three Mile Island and Chernobyl accidents. Specifically, adequate protection of the public is incompatible with the NRC's continued reliance on voluntary evaluation of severe external and internal events, voluntary adoption of mitigation measures, or the use of cost-benefit analysis to evaluate their desirability.

8. I believe my opinion is consistent with the Task Force's statement that:

Adequate protection has been, and should continue to be, an evolving safety standard supported by new scientific information, technologies, methods, and operating experience. This was the case when new information about the security environment was revealed through the events of September 11, 2001. Licensing or operating a nuclear power plant with no emergency core cooling system or without robust security protections, while done in the past, would not occur under the current regulations. As new information and new analytical techniques are developed, safety standards need to be *reviewed, evaluated, and changed, as necessary, to insure that they continue to address the NRC's requirements to provide reasonable assurance of adequate protection of public health and safety. The Task Force believes, based on its review of the information currently available from Japan and the current regulations, that the time has come for such change.* [p. 18, italics added]

9. I am concerned that over the past three decades or more, the NRC has not conducted the type of review of the adequacy of its safety regulations that is necessary to update its requirements so as to ensure that NRC safety requirements will provide the minimum level of protection required by the Atomic Energy Act. For instance, the Task Force Review points out that, over 30 years ago, the Rogovin Commission recommended that the scope of the design basis should be expanded to include a greater range of severe accidents. The Rogovin Commission explicitly stated that "[m]odification is definitely needed in the current philosophy that there are some accidents ("Class Nine accidents")^[2] so unlikely that reactor designs need not

² Class Nine accidents are now called "severe accidents." (Task Force Review p. 16)

provide for mitigating their consequences.”³. This recommendation was effectively disregarded by the NRC. Instead of imposing and enforcing mandatory requirements for prevention and mitigation of severe accidents, the NRC accepted voluntary measures and the use of cost-benefit assessments by licensees to exclude requirements for a range of preventive or mitigative measures. As a result the Task Force Review concluded that despite including some requirements for beyond-design-basis accidents, “the NRC *has not made fundamental changes to the regulatory approach for beyond-design-basis events and severe accidents* for operating reactors.” (p. 17, italics added). Even the installation of hardened vents on Mark I and Mark II BWRs was left to the voluntary discretion of the licensees. Given the NRC’s failure to make the needed changes in its basic regulatory requirements for safety since the Rogovin Commission report was issued over thirty years ago, and in light of the disastrous consequences of the Fukushima accident, which continues nearly five months after it started, I consider the current inadequacies in the NRC’s program for regulation of basic reactor safety to be extraordinarily grave problems.

Potential Effects of Task Force Review on Environmental Analyses for New Reactors, Existing Reactor License Renewal, and Standardized Design Certification

10. If the Task Force’s recommendation to incorporate severe accidents into the design basis for NRC safety requirements is considered in environmental analyses for reactor licensing decisions or standardized design certifications, I think it would have very significant effects on the outcome of those analyses, in three key respects. First, the environmental analysis would have to consider the implication of the Task Force Review that compliance with current NRC safety requirements does not adequately protect public health and safety from severe accidents and their environmental effects. Second, for reactors that are unable to comply with new mandatory requirements, it could result in the denial of licenses. Third, the cost of adopting mandatory measures necessary to significantly improve the safety of currently operating reactors and proposed new reactors is likely to be significant.

Change to Estimate of Environmental Risk

11. An analysis of the environmental implications of the Task Force Review would have to consider the ramifications of the Task Force’s implicit conclusion that compliance with current NRC safety standards does not adequately protect public health and safety from severe accidents and their environmental effects. For instance, the Task Force Review indicates that seismic and flooding risks as well as risks of seismically-induced fires and floods may be greater than previously understood by the NRC in some cases. Therefore in its environmental analyses, the NRC would have to revise its analysis to reflect the new understanding that the risks and radiological impacts of accidents are greater than previously thought.

Potential Denial of License Applications Based on Environmental Risk Analyses

12. The Task Force Review implicitly raises the potential that some reactors will be unable to

³ Rogovin Commission report (*Three Mile Island: A Report to the Commissioners and to the Public*, by Mitchell Rogovin and George T. Frampton, et al. NUREG/CR-1250 1980. (Rogovin, Stern & Huges, Washington, DC, January 1980), v. 1, p. 151

comply with new mandatory requirements, thus resulting in the denial of licenses. For instance, this would be the case if a reactor cannot be adequately backfitted to comply with present-day assessment of ground shaking induced by earthquakes. Similarly, multi-unit siting may not be allowed in certain cases due to the impracticality of meeting upgraded emergency management requirements.

Significant Changes to Cost-Benefit Analyses

13. The cost of adopting mandatory measures necessary to significantly improve the safety of currently operating reactors and proposed new reactors is likely to be significant. Adoption of a coherent regulatory framework as recommended by the Task Force, including periodic reassessments of whether the design basis is up to date with scientific assessments of flooding and seismic threats, is likely to result in significantly increased costs for nuclear reactors.

14. The Task Force Review contains numerous recommendations for consideration of new mandatory requirements for increasing the capability of the reactors, equipment, and personnel to handle and to respond to a range of severe accidents. Adoption of such measures could have high costs. This, in turn, will affect the overall cost-benefit analysis for reactors, especially the comparisons of nuclear power with alternative sources of electricity. Examples of potentially significant costs if severe accident mitigation measures are adopted follow in paragraphs 15 through 24 below:

15. If the Task Force recommendations are adopted, all existing reactors will be required to make changes to extend their capacity to handle station blackouts. This design upgrade is likely to have significant costs.

16. Similar considerations apply to new reactor combined construction and operating license applications. For instance, the Task Force recommends adding station blackout requirements to the Advanced Boiling Water Reactor, which would also likely result in increased costs. (p. 72).

17. Even where the Task Force deems some narrow issues to be already resolved by COL (combined license) applications and/or design certification applications, the interplay of other Task Force recommendations may raise environmental issues and cost concerns. For instance, while the Task Force found that the AP1000 and ESBWR designs already have a 72-hour provision for passive emergency core cooling, thereby satisfying the design requirement recommendations for station blackouts (pp. 71-72), other statements in the Task Force Review indicate the existence of environmental concerns that should be addressed in an EIS. For instance, the Task Force recommendations relating to the provision of backup power during the time beyond 72 hours relate mainly to prepositioning equipment offsite (Recommendation 4.1, p. 38) and therefore were regarded as not relevant to AP1000 and ESBWR design certifications but only to the COL process (p. 72). However, in the context of emergency preparedness, the Task Force Review notes that “[i]n the case of large natural disasters such as earthquakes, hurricanes, and floods, the phenomena challenging the plant will also have affected the local community. In these cases, *prearranged resources may not be available because of their inability to reach the plant site....*” (p. 60, italics added). Therefore the designs of the AP1000 and the ESBWR need to be reviewed in the context of their ability to mitigate the environmental impacts of station

blackout lasting more than 72 hours. The potential for destruction of infrastructure that would prevent prestaged offsite equipment from reaching the site would also need to be taken into account in environmental analyses for COLs and license extension applications.

18. Similarly, while the Task Force concludes that COL and Early Site Permit (ESP) applications already satisfy Recommendation 2.1 with respect to analysis of seismic and flooding risks (p. 71), it does not appear that all of the seismic and flooding-related implications of the Review have been addressed. Specifically, the flooding and fires that may be induced by earthquakes was closed by the NRC without imposing new requirements; the Task Force Review recommends reopening this issue (p. 32). These are issues that combine site characteristics and reactor design. For instance, the passive cooling features of AP1000s and ESBWRs involve pools of water located above the reactors. In addition, the ESBWR design has a buffer spent fuel pool in roughly the same position relative to the reactor as the Mark I design reactors (i.e., above the reactor vessel). Hence it is important to revisit this issue for these two reactor designs since they may be built at seismically active sites, including in the central and eastern United States (see paragraph 22 below), where there are active COL applications pending.

19. In the context of existing reactors, the Task Force Review recommends incorporating the latest understanding of seismic impacts and flooding (Recommendation 2, p. 30), and reopening the issue seismically induced flooding and fires (Recommendation 3, p. 32). This reassessment may also involve increased costs due to required backfits.

20. Taken as a whole, the Task Force Review's recommendations implicitly call for a review of all new reactor design certifications regarding station blackout (SBO) arrangements, including mitigation measures for SBO events that extend beyond 72 hours and spent fuel pool instrumentation and make up water supply capability. The effects of seismically induced flooding and fires on spent fuel pool arrangements should also be reviewed. All of these reviews could result in the imposition of costly prevention or mitigation measures, affecting comparisons with the alternatives.

21. In view of the events leading to the hydrogen explosions in Units 1, 3, and 4 at Fukushima, the reliability of the existing hardened vent system in Mark I and Mark II reactors has been thrown into question. The Task Force Review recommends installation of *reliable* hardened vents in all Mark I and Mark II BWRs (Recommendation 5, p. 41). Because such vents have not yet been designed and tested, their costs are unknown. However, they are likely to be substantial. These costs must be determined and evaluated for NEPA purposes for all 23 Mark I reactors and all eight Mark II reactors.

22. The recommended mandatory review of the flooding and seismic design basis of existing reactors to evaluate whether they meet the design basis safety requirements could result in greatly increased costs in some or many cases. The establishment of the Shoreline Fault just offshore the Diablo Canyon Power Plant and the Oceanside thrust in the area of the San Onofre Nuclear Generating Station provides examples of recent developments that could lead to large expenditures for restoring the design basis safety margins for these reactors. As a reflection of the uncertainty, Pacific Gas & Electric (PG&E), which owns Diablo Canyon has itself requested and obtained a delay of 52 months in its license extension application so that the necessary

seismic studies can be completed. Another example relates to seismic hazard assessments in the central and eastern United States. In that case, the NRC has concluded that “[u]pdates to seismic data and models indicate that estimates of the seismic hazard, at some operating nuclear power plant sites in the Central and Eastern United States, have increased.”⁴ The NRC does not have enough data at present to determine what, if any, backfits may be called for, but intends to use a cost-benefit approach in deciding whether they should be implemented. It specifically states that “[i]n order to progress with the Regulatory Analysis Stage, a comprehensive list of candidate plant backfits must be identified for subsequent value-impact analysis.”⁵ “Value-impact analysis” is the NRC’s terminology for a cost-benefit analysis.⁶ However, if backfitting for more severe earthquakes than were incorporated into the original design were *required* for safety rather than left to a cost-benefit analysis, the implications for comparison with the alternatives could be considerable for existing reactors in the Central and Eastern United States.

23. The Task Force noted that the same concern applies to flooding hazards, where “the assumptions and factors that were considered in flood protection at operating plants vary. In some cases, the design basis does not consider the probable maximum flood (PMF).” (p. 29) Again, protection of reactors against updated flood hazards could involve significant costs, depending on the outcome of the updated evaluations.

24. Finally, the Task Force Review points out the importance of considering mitigation measures associated with multi-unit events. Such events had not been considered before and therefore were assigned zero probability for all intents and purposes. The Task Force review recommends a revision of regulations to cover multi-unit events, for instance, to ensure adequate emergency core and spent fuel cooling for more than one unit at a time:

As part of the revision to 10 CFR 50.63, the NRC should require that the *equipment and personnel necessary to implement the minimum and extended coping strategies shall include sufficient capacity to provide core and spent fuel pool cooling, and reactor cooling system and primary containment integrity for all units at a multiunit facility.* The staff should also make the appropriate revisions to the definitions of “station blackout” and “alternate ac source” in 10 CFR 50.2. [p. 39, italics added]

Because most new applicants for COLs, such as Vogtle 3 and 4, propose to locate the new units at sites that already have reactors, the entire basis of emergency response adequacy, station-blackout related requirements, and emergency core and spent fuel pool cooling needs to be

⁴ *Implications of Updated Probabilistic Seismic Hazard Estimates in Central and Eastern United States on Existing Plants Safety/Risk Assessments*, Generic Issue 199 (GI-199), Nuclear Regulatory Commission, August 2010, at <http://pbadupws.nrc.gov/docs/ML1002/ML100270639.pdf>, p. 30

⁵ GI-199 p. 30

⁶ NRC guidelines require “that the value-impact of an alternative be quantified as the “net value” (or “net benefit”). To the extent possible, all attributes, whether values or impacts, are quantified in monetary terms and added together (with the appropriate algebraic signs) to obtain the net value in dollars. The net value calculation is generally favored over other measures, such as a value-impact ratio or internal rate of return (RWG 1996, Section III.A.2).” (*Regulatory Analysis Technical Evaluation Handbook: Final Report*, NUREG/BR-0184, Nuclear Regulatory Commission, Office of Nuclear Regulatory Research, January 1997, p. 5.2. Link at http://www.osti.gov/energycitations/product.biblio.jsp?osti_id=446391.

reconsidered for the total number of units proposed at the site. The design and cost implications could be significant and must be reconsidered and reevaluated.

Conclusions

25. I agree with the conclusions of the Task Force that significant changes to the NRC's regulatory system are needed in order to ensure that the operation of new reactors and re-licensed existing reactors does not pose unacceptable safety and environmental risks to the public. In light of the disastrous and ongoing events at Fukushima since March 11, 2011, it is clear that the issues of public safety raised by the Task Force are exceptionally grave. I also believe that it is highly likely that consideration of the Task Force's conclusions and recommendations in environmental analyses for new reactor licensing, existing reactor re-licensing, and design certification rulemakings, would materially affect the outcome of many and possibly all those studies.

The facts presented above 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

Date: 8 August 2011



INSTITUTE FOR ENERGY AND ENVIRONMENTAL RESEARCH

6935 Laurel Avenue, Suite 201
Takoma Park, MD 20912

Phone: (301) 270-5500
FAX: (301) 270-3029
e-mail: ieer@ieer.org
<http://www.ieer.org>

Curriculum Vita of Arjun Makhijani

Address and Phone:

Institute for Energy and Environmental Research
6935 Laurel Ave., Suite 201
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 Zeriffi, 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 local 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., *Comments of the Institute for Energy and Environmental Research on the U.S. Nuclear Regulatory Commission's Proposed Waste Confidence Rule Update and Proposed Rule Regarding Environmental Impacts of Temporary Spent Fuel Storage*, Institute for Energy and Environmental Research, Takoma Park, Maryland, February 6, 2009.

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.

Makhijani, A., *IEER Comments on the Nuclear Regulatory Commission's Rulemaking Regarding the "Safe Disposal of Unique Waste Streams Including Significant Quantities of Depleted Uranium,"* Institute for Energy and Environmental Research, Takoma Park, Maryland, October 30, 2009.

Makhijani, A., *The Mythology and Messy Reality of Nuclear Fuel Reprocessing*, Institute for Energy and Environmental Research, Takoma Park, Maryland, April 8, 2010.

CV updated October 11, 2010