EDO Principal Correspondence Control

FROM: DUE: 08/17/11 EDO CONTROL: G20110528
DOC DT: 07/11/11
FINAL REPLY:

Adam J. Dobson
John J. Sipos
Office of the Attorney General
State of New York

TO:

Borchardt, EDO

FOR SIGNATURE OF : ** GRN ** CRC NO:

Leeds, NRR

DESC: ROUTING:

Request to Lower the Licensing Basis Peak Cladding Temperatures of Indian Point Units 2 and 3 (EDATS: OEDO-2011-0512)

Borchardt
Weber
Virgilio
Ash
Mamish
OGC/GC
Dean, RI
Bowman, OEDO

DATE: 07/19/11

ASSIGNED TO: CONTACT:

NRR Leeds

SPECIAL INSTRUCTIONS OR REMARKS:

Ref. G20110218.

EDATS

Electronic Document and Action Tracking System

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Originating Organization: Office of the Attorney General,State of New York — **Document Received by OEDO Date:** 7/18/2011

Addressee: R. W. Borchardt, EDO — **Date Response Requested by Originator:** NONE

Incoming Task Received: Letter

STATE OF NEW YORK
OFFICE OF THE ATTORNEY GENERAL

ERIC T. SCHNEIDERMAN
ATTORNEY GENERAL

DIVISION OF SOCIAL JUSTICE
ENVIRONMENTAL PROTECTION BUREAU

July 11, 2011

R. William Borchardt
Executive Director for Operations
U.S. Nuclear Regulatory Commission
Washington D.C. 20555-0001

Re: 10 C.F.R. § 2.206 Request to Lower the Licensing Basis Peak Cladding Temperatures of Indian Point Units 2 and 3 in Order to Provide Necessary Margins of Safety – to Help Prevent Meltdowns – in the Event of Loss-of-Coolant Accidents, filed by Riverkeeper, Inc.

Dear Mr. Borchardt:

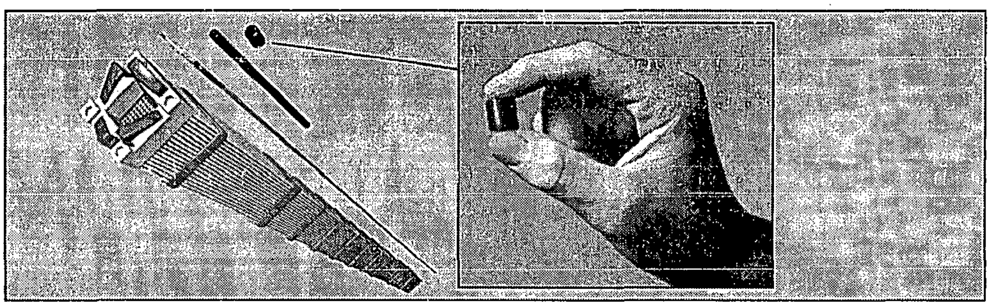
This Office respectfully submits these comments on the March 28, 2011 enforcement petition filed by Riverkeeper, Inc. requesting that the Nuclear Regulatory Commission ("NRC") lower the licensing basis peak cladding temperatures of Indian Point Units 2 and 3 in order to provide necessary margins of safety in the event of a loss of coolant accident. Riverkeeper, Inc. *10 C.F.R. § 2.206 Request to Lower the Licensing Basis Peak Cladding Temperatures of Indian Point Units 2 and 3 ("IP-2 and -3") in Order to Provide Necessary Margins of Safety – to Help Prevent Meltdowns – in the Event of Loss-of-Coolant Accidents ("LOCAS") and to have the Licensee of IP-2 and -3 Demonstrate that IP-2 and -3's Emergency Core Cooling Systems Would Effectively Quench the Fuel Cladding in the Event of LOCAS* (March 28, 2011)(ML110890956) ("the Petition").

The well-documented Petition raises serious concerns that NRC has ignored significant test data suggesting that a self-sustaining, rapid, exothermic oxidation reaction can begin at much lower temperatures than NRC has set in 10 C.F.R. Part 50, Appendix K (ECCS Evaluation Models). These data call into question the validity of the safety margins derived from existing models. For this reason, NRC should reexamine whether the regulatory peak cladding temperature should be reduced in order to diminish the risk of a meltdown in the event of a design basis LOCA.

EDO --G20110528

If, in fact, the peak cladding temperature of 2200°F provided for in 10 C.F.R. § 50.46(b)(1) and the correlations relied upon in 10 C.F.R. Part 50, Appendix K are not conservative, the consequences in the event of a LOCA would be severe, with the fuel assemblies unable to adequately dissipate heat through Emergency Core Cooling System (or "ECCS") cooling, eventually leading to runaway oxidation and the risk of a meltdown.[1] Cladding oxidation has played a significant role in the recent Fukushima event, leading to a buildup of hydrogen and consequent explosions, which continue to "puzzle" the experts. *See* Yanmei Xie, Suspected Hydrogen Explosions in Japan Puzzle US Industry, Experts, *Nucleonics Week* 52:12 (Mar. 24, 2011). Given this clear example, the regulatory basis for the peak cladding temperatures should be reexamined, and specifically, NRC should address the licensing basis peak cladding temperatures of Indian Point, because that site's unique characteristics make an accident there particularly dangerous.

Figure 1: Fuel Assembly with Fuel Rod and Individual Pellet[2]



In a light water reactor, the uranium fuel is embedded in ceramic uranium dioxide pellets which are inserted into metal tubes that are bundled together in separate fuel assemblies. The cores of both IP2 and IP3 hold millions of pellets contained in nearly 40,000 fuel rods, which are 12 foot long tubes made of a Zirconium alloy (ZIRLO)[3]. The fuel rods, in turn, are bundled into 193 separate fuel assemblies. So long as the zircaloy tubes remain intact, they can contain the uranium within the assemblies. Because of the importance of this barrier, the reactor's design basis sets a maximum temperature for the zircaloy tube or cladding to ensure that excessive core heat does not raise the temperature of the zircaloy tubes to the extent that they rupture.

To ensure that the core does not reach temperatures that will compromise the zircaloy tubes, NRC regulations mandate that reactors be designed so that the temperature of the fuel cladding during a LOCA not rise above the temperature at which the normal operation of the Emergency Core Cooling System would be unable to prevent the temperature of the fuel cladding from rising further, and to prevent a

1 By way of comparison, 2200°F = 1093°C = 1366 K.

2 The image on this page was obtained from: GAO, *NRC Needs to Do More to Ensure that Power Plants Are Effectively Controlling Spent Nuclear Fuel*, p. 2 GAO-05-339 (April 8, 2005).

3 For consistency, this comment uses the term "zircaloy," to refer to the family of zirconium alloys. Although each alloy possesses distinct properties, the metal zirconium, which reacts with hydrogen, is present in all of them.

degree of oxidation caused embrittlement that makes the tubes more likely to fail. This maximum temperature is the peak cladding temperature ("PCT"). If the cladding is maintained below this PCT, the ECCS is theoretically capable of preventing temperatures from rising to the melting points of the fuel and the cladding.

The Indian Point reactors are located 24 miles north of New York City. More than 17 million people live within 50 miles of Indian Point, a population that is projected to grow to 20 million by 2035. According to the Atomic Energy Commission ("AEC"), the NRC, and the Federal Emergency Management Agency ("FEMA"), more people live within 10 and 50 miles of the Indian Point reactors than at any other operating power reactor in the nation. Indeed, no other operating reactor site in the country comes close to Indian Point in terms of surrounding population.[4] Moreover, the communities within the 50-mile radius around Indian Point also contain some of the most densely-developed and expensive real estate in the country, critical natural resources, centers of national and international commerce, transportation arteries and hubs, and historic sites. Thus, a severe accident at Indian Point has the potential to affect more people than an accident at any other reactor in the country.

In the event of a severe accident at Indian Point, the safety of the surrounding population and communities depends on NRC safety regulations. In the case of peak cladding temperature, the regulatory basis depends on models designed more than five decades ago, and, as the Petition demonstrates, these models have been called into question by numerous experiments and studies, including:

- The CORA-2 and CORA-3 experiments, initiated with a temperature ramp rate of 1 K/sec, had rapid temperature increases of 15°C/sec, indicating a runaway oxidation reaction, that commenced at approximately 1000°C (1832°F), leading the CORA-2 and CORA-3 bundles to maximum temperatures of 2000°C and 2400°C, respectively;

- The National Research Universal Thermal-Hydraulic Experiment 1 revealed that the oxidation of the zircaloy cladding caused a 190 degree increase in temperature even after all other heating sources were removed. This indicates that in an actual reactor, where heat cannot be instantly removed, the oxidation reaction will significantly add to core temperature;

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4 *See, e.g.*, AEC, *Population Distribution Around Nuclear Power Plant Sites, Figure 2: Typical Site Population Distribution (5-50 Miles)* (April 17, 1973); FEMA, *Nuclear Facilities & Population Density Within 10 Miles* (June 2005).

- SFD Experiment CORA-13 demonstrated that a massive temperature escalation caused by runaway oxidation began at approximately 1000°C (1832°F);

- The CORA-16 and CORA-17 experiments showed that the oxidation of zircaloy was not accurately predicted by extant models, demonstrating the inapplicability of those models to the reactor environment;

- The LOFT LP-FP-2 Experiment showed that a rapid temperature increase as a result of the autocatalytic oxidation reaction of Zircaloy cladding commenced at approximately 1400 K (2060°F) – well below the 10 C.F.R. § 50.46(b)(1) PCT limit of 2200°F;

- The BWR FLECHT Zr2K Test, showed an autocatalytic oxidation reaction occurring after cladding temperatures reached between approximately 2100 and 2200°F;

- The NRU Reactor Full-Length High-Temperature 1 Test showed that autocatalytic oxidation began at approximately 2275°F or lower. The autocatalytic oxidation could not be prevented by increasing coolant flow to the fuel assemblies; and

- The PHEBUS B9R Test showed that an autocatalytic oxidation reaction began when cladding temperatures were below 1477 K (2200°F).

Since IP2 was uprated in 2004 by 3.26% and IP3 was uprated in 2005 by 4.85%, the *predicted* maximum temperature the cladding would reach is 1937°F and 1961°F, respectively (the licensing basis maximum fuel rod temperatures), well over the temperature at which runaway oxidation has been demonstrated to occur in certain of the above studies.

The recent discovery of errors in the calculation of oxidation rates and peak cladding temperatures of two types of fuel produced by General Electric and in use at the Oyster Creek and Nine Mile Point, Unit 1 facilities. *See* Nuclear Regulatory Commission, Oyster Creek, Event Notification Report 46820 (May 4, 2011)[5]; Nuclear Regulatory Commission, Nine Mile Point, Unit 1, Event Notification Report 46827 (May 6, 2011).[6] Although General Electric discovered several errors in its calculations, the net outcome of those errors was that the peak cladding

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[5] Available at: http://www.nrc.gov/reading-rm/doc-collections/event-status/event/2011/20110505en.html#en46820.

[6] Available at: http://www.nrc.gov/reading-rm/doc-collections/event-status/event/2011/20110509en.html#en46827.

temperature of fuel actually in the reactors had been underestimated by about 145 and 60 degrees Fahrenheit, respectively. The Event Notification Reports indicate that prior to discovery and correction of the errors, both reactors had been operating at temperatures such that they did not satisfy the 2200°F criteria in 10 C.F.R. § 50.46. These errors demonstrate the fine margins under which reactors operate and the possibility that the existing models and the calculations upon which licensees rely to conform their reactor and fuel characteristics to those models may not adequately protect the public.

The experiences of Three Mile Island Unit 2 and now Fukushima illustrate the danger of oxidation reactions. NRC must reexamine its regulations, and, in the meantime, it should immediately review and revise the licensing basis peak cladding temperatures of Indian Point Units 2 and 3. Additionally, while NRC undertakes that review and given the additional peak cladding temperature data identified above, it would be prudent for NRC to consider ordering Entergy – on an interim basis – to decrease the Indian Point reactors' operating temperature in order to increase the margin of safety of the licensing basis peak cladding temperatures at the Indian Point site, which has, by far, the largest surrounding population of any reactor site in the United States.

If NRC determines that § 2.206 does not provide a forum to review these important issues, then NRC should transfer the record developed before the Petition Review Board to a rulemaking process and promptly and publicly review and respond to the data presented here.

Sincerely,

s/

Adam J. Dobson
John J. Sipos
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