COMMONWEALTH of VIRGINIA

W. Tayloe Murphy, Jr.
Secretary of Natural Resources

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Robert G. Burnley
Director

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September 21, 2005

Mr. Jack Cushing
Senior Project Manager
License Renewal and Environmental Impacts
Division of Regulatory Improvement Programs
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

RE: Federal Consistency Certification: Dominion Virginia Power Company
Application for Early Site Permit for North Anna Power Station, Proposed
Addition of Units 3 and 4 (NUREG-1811)
DEQ-05-079F

Dear Mr. Cushing:

As you requested, I am enclosing a copy of the correspondence we received from the Virginia Department of Health concerning health impacts associated with the proposed addition of a third water-cooled nuclear reactor unit to the North Anna Power Station. This correspondence responds to inquiries from citizens near Lake Anna relative to health impacts of water-cooling of additional nuclear reactors at the site.

I hope this information is helpful to you. If you have questions, please feel free to call me at (804) 698-4325.

Sincerely,

Ellie L. Irons
Program Manager
Office of Environmental Impact Review

Enclosure
cc: Harry Ruth
Charles Ellis, DEQ-OEIR

COMMONWEALTH of VIRGINIA

Department of Health
ROBERT B. STROUBE, M.D., M.P.H.
STATE HEALTH COMMISSIONER
P O BOX 2448
RICHMOND, VA 23218
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1-800-828-1120

September 15, 2005

Mr. Robert Burnley
Director
Department of Environmental Quality
P.O. Box 10009
Richmond, VA. 23240

Dear Bob:

As you know, Dominion currently operates two nuclear reactors at its North Anna Power Station (NAPS). Dominion has filed an application with the Nuclear Regulatory Commission seeking a permit to add two additional reactors. A group advocating for local property owners has raised two concerns related to the potential health effects of any such new units: direct effects of heat from immersion in ambient waters by recreational bathers, and the potential adverse effects of any changes in the concentrations of microorganisms in those waters. Charles Ellis, III, in your department has asked us to comment on those concerns.

Background

Waste heat at the NAPS is disposed of by running water from North Anna Reservoir through condensers. The heated water is then discharged to a series of three connected cooling lagoons, separated from the main body of the lake by dikes (together, the Reservoir and the lagoons make up 'Lake Anna'). These lagoons are collectively referred to as the Waste Heat Treatment Facility (WHTF). According to Dominion's Early Site Permit (ESP) application (revision 5, found at http://www.nrc.gov/reactors/new-licensing/esp/north-anna.html), "the WHTF is considered by the VDEQ to be a mixing zone for the purpose of complying with the state water quality standards under the VPDES program. Virginia Power considers the WHTF to be an integral part of the power station, and as such it has never been operated as an extension of the North Anna Reservoir for the purposes of public recreational use. However, with Virginia Power's permission, homeowners on the shoreline of the WHTF have access to it for recreational use (boating, fishing, swimming). This limited access and use would remain unchanged following the addition of the cooling systems for the new units."

The WHTF discharges to the North Anna Reservoir through the Virginia Power owned and operated Dike #3. The Reservoir has public access and is used for recreational boating, swimming, fishing, camping, and picnicking, and has residential (vacation and year-round) housing along its shores. Dominion estimates that, with the existing units operating, the heated

effluent's residence time in the WHTF is approximately 7 days, where about half of the waste heat is dissipated. The remaining waste heat is dissipated to the atmosphere from the Reservoir surface.

Current Thermal Profile

Fixed water temperature recorders continuously record water temperatures at 11 locations: 10 in the Reservoir and WHTF areas, and one in the North Anna River downstream of the dam. Data are supplied by Dominion in its application for a 25-year period (Units 1 & 2 came on line in 1978 and 1980, respectively):

- The *mean* observed daily surface water temperatures during July and August were 29.1 degrees Celsius (84.3 F) in mid-reservoir (Burrus Point), 31.6 C (88.9 F) near the outfall from the third lagoon to the reservoir (Dike #3), and 35 C (95 F) in the first lagoon (at discharge point).
- The *maximum* daily (24-hour average) observed temperatures for these sampling stations were 31.9 C (89.4 F), 35 C (95 F), and 39.1 C (102.4 F), respectively.
- Daily temperature readings throughout the year were observed to *equal or exceed* 30.5 C (87 F) 2.4%, 15%, and 30% of the time at these stations, respectively.

Projected Thermal Changes

Dominion uses a model originally developed at the Massachusetts Institute of Technology (MIT) to model the thermal effects on receiving waters of a third reactor (Dominion's scenario #2) using a once-through cooling system similar to units 1 & 2 (any fourth unit would likely use a closed cycle dry cooling tower system). The model makes these projections while assuming all units to be operating continuously at full station load:

- The projected *mean* daily surface water temperatures during July and August for the same three sampling stations mentioned above would be 32.3 C (90.1 F) in mid-reservoir (Burrus Point), 35.2 C (95.4 F) near the outfall from the third lagoon to the reservoir (Dike #3), and 39.6 C (103.3 F) in the first lagoon (at discharge point).
- The projected *maximum* daily (24-hour average) temperatures for these sampling stations would be 35.6 C (96.0 F), 38.8 C (101.9 F), 42.9 C (109.3 F), respectively.
- Daily temperature readings throughout the year are projected to *equal or exceed* 30.5 C (87 F) 22%, 34%, and 48% of the time at these stations, respectively.

Heat-related Risks

Burn injury is a risk if one is exposed to hot water 45 C (113 F) or higher. Most of the medical studies on this subject come from burn injuries sustained from hot tubs or showers. Severity of burn injury is correlated with the temperature of the water and the length of time one is submerged. Submersion in water at 45 C (113 F) can be expected to cause second degree burns (no irreversible damage) after two hours of exposure, and 3rd degree full thickness injury after three hours.

Immersion in water at temperatures above the body's normal temperature of 37.0 C (98.6 F) can be expected to affect body temperature, sweating, and heart rate. Deaths from thermal stress have been reported in saunas, diving environments, and hot tub baths. Consumption of alcohol is sometimes a contributing factor. The Consumer Product Safety Commission (CPSC) knows of several deaths from extremely hot water (approximately 43.3 C or 110 F) in a spa. High temperatures can cause drowsiness which may lead to unconsciousness, resulting in drowning. In addition, raised body temperature can lead to heat stroke and death. In 1987, CPSC helped develop requirements for temperature controls to make sure that spa water temperatures never exceed 40 C (104 F). Persons with heart disease, young children, the elderly, pregnant women and persons with spinal cord or peripheral nerve disorders are thought to be particularly vulnerable to the effects of submersion in hot water.

Microbiological Risks

Primary amoebic meningoencephalitis (PAM) is a rare but nearly always fatal infection caused by *Naegleria fowleri*, a thermophilic ('warmth loving'), free-living ameba that naturally inhabits freshwater ponds, lakes, and rivers, minimally chlorinated pools, and hot springs throughout the world. These waters need not be polluted with other microorganisms in order for the ameba to survive or multiply under the right conditions.

PAM results when amoebae-containing water incidentally enters the nose during swimming or other aquatic activity, followed by migration of amoebae to the brain through the olfactory nerve. Symptoms occur one day to two weeks after exposure, are indistinguishable from fulminant bacterial meningitis and can include headache, fever, stiff neck, anorexia, vomiting, altered mental status, seizures, and coma. Death typically occurs three to seven days after the onset of symptoms.

Although the consequences of infection are often devastating, cases are quite rare. Death certificate data yield only 35 deaths nationally due to PAM (ICD9 code 136.2 and ICD10 code B60.2) for the years 1979-2002. One (2.9%) of these deaths was in Virginia.

The majority of cases occur during the summer months and among children. Typically, these infections are associated with swimming in freshwater bodies in the late summer months because the free-living ameba *N. fowleri* proliferates in warmer waters.

Scientists have reported isolating pathogenic *Naegleria* species from bodies of water that were thermally enriched by power plant effluents in Illinois, Minnesota, Texas, and Virginia. These species have also been found to survive and grow well in natural hot springs and solar-heated ponds. The organism begins to proliferate at temperatures around 30 C (86 F) and thrives especially well (compared to its competitors) at temperatures of 35 to 45 C (95 to 113 F) where it can reach concentrations in water and sediments of 10 to 100 organisms per liter or gram.

Risk Characterization

Researchers have created risk assessment models based on animal experiments, epidemiologic data, and conservative assumptions to estimate the risk of PAM from a single

episode of swimming. This model predicts a risk of approximately one chance in 10 million when the concentration of organisms is 10 *N. fowleri* amoebae per liter.

Standards

There are no public health standards for *Naegleria* (or *N. fowleri*) for recreational waters or drinking water sources in Virginia or the U.S. The government of Australia has established an action level of two *N. fowleri* organisms per liter (or detection in a 500 mL sample) for *drinking water sources*. French health authorities have set a maximum level of 100 *N. fowleri* organisms per liter, not to be exceeded in water courses where human exposure is possible.

Comparable Risks

As mentioned above, mortality data indicate there has been one death in Virginia due to PAM during the period 1979 to 2002. By comparison, during that period there have been 49 deaths in Virginia due to being struck by lightning (ICD9 code 907 and ICD10 code X33), and 548 deaths in Virginia due to recreation-associated drowning (ICD codes 910 to 910.2 and ICD10 codes W69 to W69.9).

Recommendations

Persons with heart disease, parents and guardians of young children, the elderly, pregnant women and persons with spinal cord or peripheral nerve disorders should be cautious of prolonged immersion in waters that are warmer than body temperature. Bodies of water that have a temperature exceeding 40 C (104 F) should be considered unsafe for recreational activity for all persons due to the effects of heat alone.

Common sense suggests that to reduce the risk of PAM, swimmers might wish to avoid swimming in freshwater venues when water temperatures are high, e.g. when surface water temperatures are greater than or equal to 35 C (95 F). Swimmers should avoid shallow stagnant areas and minimize forceful entry of water up the nasal passages during jumping or diving activities (i.e., by holding one's nose or wearing nose plugs) and avoid digging in the sediment (where amoebae may be concentrated) while under water.

Should further information be needed, please contact Carl W. Armstrong, MD, Director, Office of Epidemiology, Virginia Department of Health, at 864-7905.

Sincerely,

Robert B. Stroube, M.D., M.P.H.
State Health Commissioner

cc: Susan McLeod, MD, MPH
District Director, Thomas Jefferson Health District