WATTS BAR NUCLEAR PLANT

BIOLOGICAL ASSESSMENT

Tennessee Valley Authority
Nuclear Regulatory Commission

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INTRODUCTION

The Tennessee Valley Authority (TVA) is a regional resource development agency of the United States. Among its activities are the generation and transmission of electric energy. TVA is responsible for providing electricity to parts of seven states, an area inhabited by almost eight million people.

In 1970, TVA proposed to build and operate Watts Bar Nuclear Plant (WBN) to help meet an increasing demand for electricity. WBN is a two-unit plant, located on the Tennessee River just downstream from Watts Bar Dam. TVA issued a final environmental impact statement (EIS) in 1972 that evaluated the potential environmental impacts of constructing and operating WBN. That EIS mentioned the bald eagle (*Haliaeetus leucocephalus*) as a relatively common visitor to the WBN area and addressed potential impacts on freshwater mussel species. Endangered and threatened species were not discussed as they would be today because the Endangered Species Act (ESA) was not passed and signed into law until 1973.

The Nuclear Regulatory Commission (NRC) is the federal agency which licenses and regulates commercial nuclear power plants in this country, including those operated by TVA. In 1978, NRC issued a final environmental statement (FES) that evaluated the potential environmental impacts of completing and operating WBN. That FES addressed the bald eagle and two endangered freshwater mussel species (pink mucket, *Lampsilis orbiculata*; and dromedary pearly mussel, *Dromus dromas*). Bald eagles had been seen in the area and both mussel species were known to

occur approximately seven river miles downstream from WBN. NRC concluded that operation of WBN would not affect these species.

Completion of WBN has taken longer than anticipated. Since the release of the TVA EIS and the NRC FES, the U.S. Fish and Wildlife Service (FWS) has added species to the federal lists of endangered and threatened wildlife and plants, and some other listed species have been found in the vicinity of WBN. Today, seven federal endangered or threatened animal species are known to exist near WBN.

This biological assessment has been prepared to support TVA and NRC consultations with FWS on the WBN project. The assessment presents a description of pertinent project components, summarizes information about the seven listed species known to occur in the vicinity of WBN, and describes the potential impacts of plant operation on these species. The discussions and impact determinations presented in this assessment are based upon information contained in the large number of reports and other documents listed as references.

PROJECT DESCRIPTION

Watts Bar Nuclear Plant (WBN) is located on the west (right descending) bank of Chickamauga Reservoir near Tennessee River Mile (TRM) 528. This two-unit nuclear generating plant is designed for an electrical output of about 2,540 megawatts. WBN is situated approximately two river miles downstream of Watts Bar Dam (TRM 529.9) and one mile downstream from the four-unit Watts Bar Fossil Plant (WBF), also located on the west bank of Chickamauga Reservoir (TRM 529). WBF was placed in "Long Term Standby for Restart" status in March 1983. Figure 1 shows the locations of these TVA facilities along the river.

Construction of all major exterior facilities at WBN and associated transmission lines was completed during the 1970s. Unit 1 is now essentially complete and TVA expects to initiate operation of this unit in the spring of 1995. Unit 2 is approximately 65 percent complete, and its completion is being reevaluated by TVA.

Five off site transmission lines were built as part of the WBN project. Two of these lines (loops to connect with the Bull Run - Sequoyah line) were less than 9 kilometers (5.5 miles) long; two others (Watts Bar - Roane and Watts Bar - Sequoyah #2) were approximately 65 kilometers (40 miles) long, and the remaining line (Watts Bar - Volunteer) was nearly 150 kilometers (90 miles) long. The routes of these lines are indicated on Figure 2.

WBN will be operated in a closed cycle cooling mode, using one natural draft cooling tower for heat dissipation for each nuclear generation unit. Makeup water and other water supply requirements will be obtained from an intake channel and pumping station now in place on the river at TRM 528.0. Blowdown from the cooling towers will be

discharged through a multiport diffuser system now in place in the river channel at TRM 527.9 (Outfall 101). These intake and discharge structures are indicated on Figure 1.

The intake channel has a cross sectional area of approximately 155 m^2 (1650 ft^2) at Chickamauga Reservoir winter pool elevation 206 m (675 ft) mean sea level, and 293 m^2 (3159 ft^2) at summer pool elevation 208 m (682.5 ft). Corresponding average velocities into the intake channel are 0.03 m/s (0.1 ft/s) and 0.016 m/s (0.05 ft/s). Maximum intake pumping flowrate for two-unit operation will be approximately 4.0 m^3/s (143 cfs). This pumping flowrate represents about 0.5 percent of the long-term average flow past the plant (736 m^3/s or 26,300 cfs).

Blowdown is discharged directly to the diffuser system in the river or into a holding pond for later release through the diffusers. As required by the current National Pollutant Discharge Elimination System (NPDES) permit for this site, discharges will be stored in the holding pond when releases from Watts Bar Dam are less than 98 m^3/s (3,500 cfs). In emergency situations, overflow from this pond will be discharged to the river using a drainway with a mouth at TRM 527.2 (Outfall 102). Blowdown from the cooling towers will be discharged at a rate of between 1.3 and 2.4 m^3/s (45 and 85 cfs). Releases for normal two-unit operation will be 2.4 m^3/s (85 cfs), approximately 0.3 percent of the long-term average flow. The maximum discharge through the diffusers will be approximately 4.8 m^3/s (173 cfs) on occasions when the holding pond is being drained while the blowdown discharge from the cooling towers is being routed directly to the diffusers. This would represent about 0.7 percent of the long-term average flow in the river.

The diffuser system consists of two pipes extending into the main river channel (Figure 3). The downstream pipe segment extends 90 m (300 ft) into the channel with a 50 m (160 ft) long, 1.3 m (4.5 ft) diameter diffuser section located in the deepest portion of the river channel. The upstream pipe segment extends 140 m (450 ft) with a 25 m (80 ft) long, 1.0 m (3 ft) diameter diffuser section beginning where the downstream diffuser section ends. The diffuser sections are half buried in the river bottom with two rows of 2.5 cm (1 in) diameter ports at 7.5 cm (0.25 ft) spacing, oriented at 45° in the downstream direction. The exit jet velocity will vary depending on operational mode, from 2 to 5 m/s (6 to 16 ft/s). The expected discharge temperature will depend on cooling tower performance and is projected to vary from 17°C (63°F) in January to 35°C (95°F) in July.

All WBN point source discharges and storm water runoff points are required to comply with conditions established in the current NPDES permit for the site (now Permit No. TN0020168, Tennessee Water Pollution Control, 1993). This permit also requires substantial chemical and toxicity monitoring of WBN discharges.

Under current WBN procedures, minor releases of radioactive materials may be discharged from the plant through the discharge diffusers. Liquids potentially containing radioactive wastes will be collected, tested, and, if necessary, processed before being released to the Tennessee River via the discharge diffusers. Additional releases could occur from the discharge of low level radioactive liquid effluents from the turbine building station sump to the yard holding pond via the low volume waste treatment pond. Such a release would occur only in the unlikely event of a primary-to-secondary leak. Releases from the liquid

waste processing system are controlled by NRC regulations and discharged in accordance with the NPDES permit.

TVA also has developed a Radiological Emergency Plan to protect the health and safety of plant personnel and the public in the event of a radiological emergency at a nuclear plant. This plan has been developed in accordance with NRC and Federal Emergency Management Agency regulations and guidelines. The TVA plan addresses organizational responsibilities, capabilities, actions, and guidelines to be followed by agency staff during a radiological emergency. State and local agencies are responsible for ordering and implementing actions to protect the health and safety of the public off site.

A variety of chemicals are used for different purposes at WBN. These chemicals are used to control corrosion in various kinds of metals, control slimes and other organic fouling materials, inhibit growth of Asiatic clams, and for a variety of other purposes. Table 1 lists the chemicals being used at WBN and the anticipated quantities of their resulting end products which will be discharged. The potential sources and quantities of these chemicals are controlled by a site Chemical Traffic Control Program. All chemical discharges at WBN are controlled by the NPDES permit.

LISTED SPECIES

Information collected in recent years indicates that the Tennessee River and tributary streams near WBN contain representatives of one threatened fish (snail darter, Percina tanasi) and four endangered freshwater mussels [fanshell, Cyprogenia stegaria; dromedary pearly mussel, Dromus dromas; pink mucket, Lampsilis abrupta (= orbiculata); and rough pigtoe, Pleurobema plenum]. Two endangered terrestrial species (bald eagle, Haliaeetus leucocephalus; and gray bat, Myotis grisescens) also are known to occur in the vicinity of this site. No endangered or threatened species are known to occur along WBN-related transmission line corridors which do not occur adjacent to the site.

Aquatic Species

Since 1973, TVA aquatic biologists have conducted substantial field work on aquatic life in the Tennessee River downstream from Watts Bar Dam, primarily associated with preoperational monitoring for WBN. Starting in 1983, TVA has monitored the status of mussel stocks in three areas of relatively high density (i.e., "mussel beds") located just upstream, just downstream, and several miles downstream from the WBN discharges (Figure 3).

Native mussel resources are now known to occur in various concentrations throughout the Watts Bar tailwater. Since 1978, a total of 31 freshwater mussel species has been reported from this tailwater (Gooch, et al., 1979; TVA, 1986; Ahlstedt, 1989; 1991; 1994; Jenkinson, 1991). The most abundant species are the elephantear (Elliptio crassidens), Ohio pigtoe (Pleurobema cordatum), and pimpleback (Quadrula pustulosa). The results of several recent studies (primarily TVA, 1986;

and Ahlstedt, 1994) indicate that very few mussel species have reproduced successfully in this river reach during the last 30 or more years. The causes of this reproductive failure are unknown.

Recent mussel surveys in the Watts Bar tailwater provide information about the local distribution of the four endangered mussel species (Table 2). The dromedary pearly mussel (Dromus dromas), listed as endangered in 1976 (FWS, 1976), is the most uncommon of these species. Only four specimens of this species have been collected from this river reach -- three in 1978 and one in 1983 (Gooch, et al., 1979; TVA, 1986). No other specimens have been found in subsequent surveys (Ahlstedt, 1989; 1991; 1994; Jenkinson, 1991). All four specimens were encountered on Hunter Shoals, between River Miles 520 and 521 (approximately seven miles downstream from the WBN site). Surviving populations of this mussel species occur in the Cumberland River in middle Tennessee and in the Clinch and Powell Rivers in northeast Tennessee and southwest Virginia (FWS, 1984a). Critical habitat has not been designated for this or any of the other endangered mussel species included in this assessment.

The fanshell (Cyprogenia stegaria) and rough pigtoe (Pleurobema plenum) were both found consistently in very low numbers (1 to 3 per year) in the Watts Bar tailwater between 1983 and 1985 (TVA, 1986); however, neither species has been encountered during any subsequent survey (Ahlstedt, 1989; 1991; 1994; Jenkinson, 1991). Both species were found more consistently on Hunter Shoals, but a few specimens of each species also were found between River Miles 528 and 529. Reproducing populations of the fanshell persist in the Green River, central Kentucky; the Licking River, eastern Kentucky; and the Clinch River, northeast

Tennessee and southwest Virginia (FWS, 1991). The rough pigtoe persists in the Green and Barren Rivers, central Kentucky; the Cumberland River, central Tennessee; and the Clinch River, northeast Tennessee and southwest Virginia (FWS, 1984b). The rough pigtoe was added to the list of endangered species in 1976 (FWS, 1976) but the fanshell was not added to that list until 1990 (FWS, 1990).

The pink mucket [Lampsilis abrupta (= orbiculata)] was listed as endangered in 1976 (FWS, 1976). At least a few specimens of this species have been found during each mussel survey conducted in the Watts Bar tailwater since 1978 (Gooch, et al., 1979; TVA, 1986; Ahlstedt, 1989; 1991; 1994; Jenkinson, 1991). Representatives of this species have been found on all three beds involved in the preoperational monitoring program as well as upstream toward the dam and at intermediate sites. In terms of relative abundance, the pink mucket consistently accounts for 0.3 to 0.7 percent of the mussel community encountered. Besides the Watts Bar tailwater, the pink mucket is known to exist at scattered locations from the Kanawha River, West Virginia; west to the Osage and Meramec Rivers, Missouri; south to the Black River, Arkansas; and east to the Tennessee and Cumberland Rivers in Tennessee. The most upstream site in the Tennessee River watershed where this species has been found is the Clinch River, northeast Tennessee (FWS, 1985).

So far as is known, each of these endangered mussel species has similar feeding and reproductive requirements. Adult members of these species live embedded in cobble or gravel river bottoms where water currents prevent excessive silt accumulation. They feed by filtering small food particles (detritus, algae, etc.) out of the water. Reproduction involves a stage when the larvae (glochidia) must become

temporary parasites on certain fish species in order to complete their development. The required "fish hosts" are unknown for most of these species; however, the pink mucket is reported to parasitize sauger (Stizostedion canadense) and freshwater drum (Aplodinotus grunniens) (FWS, 1985). Members of these mussel species may live for 40 years or more.

The only other federally-protected aquatic species known to occur near WBN is the snail darter (Percina tanasi). This small fish was listed as endangered in 1975 (FWS, 1975) based on the assessment that its natural habitat would be destroyed by impoundment. In 1976, two snail darters were observed at Tennessee River Mile 515 and, in 1981, snail darters were discovered in Sewee Creek, a small stream which enters the Tennessee River at River Mile 524.6 (FWS, 1983). The Sewee Creek population is now one of six known snail darter populations, all of which occur in direct tributaries of the Tennessee River between Huntsville, Alabama, and Knoxville, Tennessee. The core of each population apparently exists in the smaller stream, but young snail darters routinely drift down into the river during their first year of life. As the name implies, these fish eat primarily snails, but aquatic insects also contribute to their diet. The snail darter was reclassified to threatened status in 1984 (FWS, 1984c), largely based on the increased number of known populations. No critical habitat is currently identified for this species.

Three aquatic species known to occur near WBN have been identified as candidates for federal endangered or threatened status. Two of these species (Tennessee clubshell mussel, Pleurobema oviforme, and blue sucker, Cycleptus elongatus) have been found occasionally in the

Tennessee River near WBN. The third species (eastern hellbender, Cryptobranchus a. alleganiensis) has been observed upstream in Sewee Creek. The blue sucker is a relatively widespread, large river fish which is seldom collected. The Tennessee clubshell is known to occur in a number of smaller streams across the Tennessee River system while the hellbender occurs more widely across the eastern United States.

Terrestrial Species

Two federally-protected terrestrial species are known to occur near WBN: the bald eagle (Haliaeetus leucocephalus) and gray bat (Myotis grisescens). In 1972, when bald eagles were described as fairly common visitors to Watts Bar and Chickamauga Reservoirs, the wintering population in this area was probably no more than six to eight birds. Since 1972, the Watts Bar/Chickamauga bald eagle population has increased substantially to about 30 birds (Tennessee Wildlife Resources Agency, unpublished data), as has been the case elsewhere across the range (FWS, 1994). The first bald eagle nesting observed in this area was in 1994, when a pair built, then abandoned a nest about 6 kilometers (4 miles) south-southwest of the WBN site (Hatcher, 1994; R. M. Hatcher, Tennessee Wildlife Resources Agency, personal communication).

Bald eagles living south of the 40th parallel were listed as endangered in 1967 (under the Endangered Species Protection Act of 1966) because of declines resulting from pesticide poisoning, habitat loss, and shooting. No critical habitat has been designated for this species. Recovery Plan objectives for this species in the southeastern states (FWS, 1984d; 1989) include a goal of 15 occupied breeding territories in Tennessee. Now that many rangewide eagle recovery objectives have been

met, the FWS has recently proposed to reclassify most of the eagle population in the lower 48 states from endangered to threatened status (FWS, 1994). If adopted, this reclassification would apply to bald eagles living in Tennessee.

Bald eagles feed primarily on fish which are either caught live or found dead. They also eat a variety of other vertebrates, especially waterfowl. Bald eagles usually build their nests in large trees on the edge of a woodland within 3 kilometers (2 miles) of water. When not nesting, these birds roost on wooded slopes near water (FWS, 1989).

Gray bats (Myotis grisescens) occur throughout most of the limestone cave areas of the United States south and east of Missouri, southern Illinois, and southern Indiana (FWS, 1982). These bats roost in caves throughout the year, all together from late summer through mid-spring but separated into bachelor caves and maternity caves while females are caring for the young. Gray bats feed over water on adult aquatic insects, primarily mayflies, and often travel 20 kilometers (12 miles) or more from their roost caves to feeding sites. The species was listed as endangered in 1976 because of population declines due mostly to habitat loss and human disturbance of caves (FWS, 1982). While several caves are known to be important to gray bat survival, critical habitat has not been designated for this species.

The nearest cave in which gray bats have been found is located about 6 kilometers (4 miles) downstream from WBN. This cave is visited by male bats during the summer. The cave also receives heavy human visitation, which probably prevents its regular occupancy by bats (Harvey and Pride, 1986). Three other caves regularly occupied by gray bats occur between 15 and 30 kilometers (10 and 20 miles) from WBN. No

significant change in the bat population of these caves has occurred in recent years. Gray bats from these caves probably forage over the reservoir adjacent to and downstream from WBN.

No other listed endangered or threatened terrestrial species are known to occur regularly in the WBN area. The 1972 TVA EIS mentioned five other terrestrial animals, now listed as endangered, which once occurred in east Tennessee and might be found near WBN. Three of these species (red-cockaded woodpecker, Picoides borealis; Bachman's warbler, Vermivora bachmanni; and Kirtland's warbler, Dendroica kirtlandii) have never been observed near WBN. The other two species (peregrine falcon, Falco peregrinus; and Indiana bat, Myotis sodalis) migrate or range through the general vicinity of Watts Bar and Chickamauga Reservoirs but are not known to occur regularly near WBN.

Several plant species which have been listed as endangered or threatened in recent years are known to occur in east Tennessee; however, none of them have been found during plant surveys in the vicinity of WBN or on WBN-related transmission line corridors. A plant candidate for possible federal endangered or threatened status (a bugbane, Cimicifuga rubifolia) has been found as close as 6 kilometers (4 miles) from WBN. This bugbane, which lives on rich, forested slopes over limestone bedrock, occurs from western Virginia to northern Alabama and at a few sites in western Tennessee and Kentucky. Populations are known from 13 eastern Tennessee counties.

IMPACT ASSESSMENT

Construction Impacts

Construction of the intake channel, discharge diffusers, and other in-water facilities at WBN, as well as major exterior land-based facilities and transmission lines, have been completed. No additional major exterior construction is proposed, and no new construction effects on endangered or threatened species are anticipated.

Operational Impacts

Operational impacts from WBN on listed aquatic species could occur through the release of radioactive, thermal, or chemical discharges to the river. Those discharges could affect bald eagles and gray bats if the fish and insects they feed upon were affected. Endangered or threatened terrestrial species also could be affected by encounters with the cooling towers, transmission lines, and other structures built as part of the WBN project or with activities and chemicals used to maintain those structures. A variety of studies have been conducted to evaluate the risk of adverse environmental impacts from these potential operational impacts, the results of which are presented in the following sections.

Radiological Impacts. While there are no current radioactive releases from WBN, the potential for eventual releases of radioactive materials from the plant has been estimated at various times. Table 3 compares the estimated annual WBN liquid radioactive releases and resulting doses presented in the TVA EIS, the WBN Final Safety Analysis

Report (FSAR) Amendment 77, the NRC FES, and recent data from the TVA Sequoyah Nuclear Plant (as submitted in semi-annual radiological effluent reports). Data from Sequoyah are relevant because that plant uses essentially the same radiological waste system design as WBN and the two systems are expected to operate in much the same manner. The Sequoyah monitoring period chosen for this comparison most closely represents expected operation of the WBN liquid radwaste system (i.e., when demineralizers were being used to treat liquid radwaste). This comparison indicates that the WBN FSAR estimates, even though based on very conservative (worst-case) assumptions, continue to be well within the NRC dose guidelines given in 10 CFR Part 50, Appendix I.

The radiological monitoring TVA conducts around both Sequoyah and Watts Bar nuclear plants also provides some specific information on radioactivity levels in fish and Asiatic clams. Data collected in 1993 (TVA, 1994a; 1994b) indicate that concentrations of Cesium-137 and Strontium-90 found in fish were essentially equivalent upstream and downstream from Sequoyah, suggesting fallout or other sources unrelated to nuclear plant operation. Only naturally occurring radioisotopes were identified in the Asiatic clams.

Based on these conclusions, TVA and NRC have determined that the doses to the public resulting from the discharge of radiological effluents from WBN will be less than two percent of the NRC guidelines given in 10 CFR 50, Appendix I. Nothing in the estimates or existing plant monitoring data suggest any radioactive impact on mollusks, fish, or species which might prey on them.

Thermal Impacts. The NPDES permit establishes monitoring requirements and/or limits for the WBN discharges into the Tennessee River. The current NPDES permit for this site required that TVA conduct temperature modeling studies to determine the appropriate daily average discharge temperature limit from the diffusers (Outfall 101) and emergency overflow (Outfall 102). These studies were completed and a report submitted to the state of Tennessee in December 1993 (Lee et al., 1993). Modeling results presented in that report indicate the maximum temperature of the WBN diffuser discharge (assuming both units were operating during hot weather conditions) could be as high as 36.3°C (97.3°F). At the downstream end of the mixing zone, the model results predicted a maximum river temperature (also under hot weather conditions) of 28.1°C (82.6°F) and a maximum temperature rise (two units, cold weather conditions, and low dam releases) of 1.0 C° (1.8 F°). Average downstream river temperatures are predicted to be lower than 25°C (77°F), and the average temperature rise is predicted to be less than 0.2 C° (0.3 F°). Mixing zone sizes used in these model studies were 75 x 75 m (240 x 240 ft) of full river depth for the discharge diffuser and 300 x 900 m (1000 x 3000 ft), largely on the surface, for the emergency overflow.

Upper temperature limits are not known for any of the endangered mussel species or the snail darter; however, water temperature data (presented in Lee et al., 1993) indicate that releases from Watts Bar Dam have exceeded 27°C (80°F) relatively often during the last 15 years. Temperature data from several Tennessee River watershed locations which support diverse mussel and fish communities (Poppe and Fehring, 1986) include a number of maximum temperatures above 32°C (88°F).

The small volumes of water discharged from WBN will have very little effect on temperature in the Tennessee River. The possible maximum temperature of the discharge, which would occur rarely, would exist only in a small part of the mixing zones near the diffusers. Warmed water coming out of the 45°-angled jets on the diffusers (Figure 3) would rise in the water column, without effect on bottom-dwelling species such as mussels or snail darters. Average and maximum temperatures at the downstream ends of the mixing zones will be only very slightly different from existing conditions in the river and well within the range of temperatures endangered and threatened aquatic species in the area encounter naturally. Based on this information, TVA and NRC have concluded that thermal discharges from WBN will not impact listed mussels, the snail darter, or prey of the bald eagle or gray bat.

Chemical Impacts. The NPDES permit also controls the discharge of chemicals from WBN. However, it is possible that listed species living in or near the discharge mixing zone could be affected by levels of some plant effluents allowed under typical NPDES permit limits. TVA has been aware of this potential effect for some time and has been working with the state of Tennessee to better determine safe discharge concentrations for the chemicals used at WBN.

Monthly chronic toxicity tests were conducted on WBN discharges over a year-long period when chemicals were being used by the plant. These test results (presented in Table 4) did not identify toxicity in undiluted Outfall 101 effluent based on the responses of either daphnids (*Ceriodaphnia dubia*) or fathead minnows (*Pimephales promelas*). Both species are standard NPDES toxicity biomonitoring organisms.

In addition, two studies have been conducted to evaluate the potential impact of chemical use by WBN on the paper pondshell, Anodonta imbecillis, as a representative freshwater mussel. An initial study, conducted in 1991 jointly by the TVA Toxicity Testing Laboratory and Presbyterian College, Clinton, South Carolina, evaluated toxic responses of daphnids and 8-10 day old juvenile freshwater mussels to Outfall 101 effluent including the mixture of chemicals used at WBN. The results (also presented in Table 4) indicate that daphnid survival was reduced during the first 24 hours of the 7-day exposure period in treatments containing the active ingredients in a molluscicide being used to control Asiatic clams at WBN (dodecylguanidine hydrochloride - "DGH", and alkyldimethylbenzylammonium chloride - "QUAT"). In contrast, juvenile mussels were not affected by any treatment during their 9-day tests. A repeat of the study using WBN effluent including various amounts of DGH/QUAT in combination with other chemicals used at WBN showed toxicity to daphnids but not to fathead minnows (Table 4, also).

A second study was conducted by TVA and two laboratories (EMPE, Nashville, Tennessee, and Presbyterian College) under contract with the Tennessee Wildlife Resources Agency (TVA, 1994c). This study evaluated the impact of synthetic water containing DGH/QUAT on non-target species [daphnids, fathead minnows, paper pondshell, Elliptio angustata (another freshwater mussel), and Brachionus calyciflorus (a rotifer)]. Results from this study (Table 5) were similar to the effluent test in that daphnids were the most sensitive organisms tested. The 96-hour LC_{50} for daphnids was 0.07 mg/L (whole product, without silt), compared with the 9-day LC_{50} for the pondshell of 0.14 mg/L without silt, and 1.07 mg/L with silt present (silt is a detoxifying agent for DGH/QUAT). The

9-day LC_{50} for E. angustata was 8.74 mg/L with silt present. In this study, the daphnids were 15 times more sensitive to DGH/QUAT than the more sensitive mussel species (paper pondshell) tested under conditions comparable to those which would occur in the river (i.e., when silt was included in the test).

These monitoring and experimental data indicate that mussels and fish would not be affected if they were exposed to the undiluted chemical effluent from WBN. In addition, the large dilution which occurs as the discharge mixes with water and silt in the river will provide a further margin of safety to mussels and fish outside of the mixing zone. To ensure that plant operations have minimal adverse effects on mussel populations, TVA will continue to monitor area mussel beds and perform toxicity tests. If adverse effects are detected, steps will be taken to eliminate the effects, including altering plant chemical uses.

Although the sensitivity of listed mussels and the snail darter are not known, the available toxicity data can be used to indicate if they could be affected. The order of magnitude greater sensitivity of daphnids compared to the fish and mussels which have been tested indicates that the whole effluent toxicity biomonitoring requirement at WBN (using daphnids as a test organism) will provide an ample margin of safety for listed species occurring both near and downstream from the WBN discharges.

Chemical discharges from WBN also are not likely to have any effect on bald eagles or gray bats. The toxicity testing data indicate that survival and growth of prey for these species are unlikely to be affected by the levels of chemicals released into the river.

Impacts of Structures. The possibility exists that bald eagles and gray bats might collide with buildings and cooling towers on the WBN site, and with lines and towers along the transmission corridors. Bald eagle mortality is extremely unlikely from collisions with buildings because of their sharp vision and daylight habits. Impacts with less-visible transmission lines could be more likely. When the WBN transmission lines were built they conformed with applicable routing and engineering standards to reduce collisions and bird electrocutions (Olendorff, et al., 1981). The routes for those lines minimized water crossings and avoided waterfowl concentration areas. The presence of vibration dampers and/or aircraft warning markers on lines which do cross wide expanses of water further reduce the risk of eagle accidents. No eagle collisions have ever been reported on the WBN site or along any TVA transmission line.

Gray bats are extremely unlikely to be affected by collisions with structures or transmission lines. Bats are adept at avoiding stationary objects and this type of bat mortality is extremely rare (Griffin, 1970). The portions of WBN transmission lines which cross water are higher than normal gray bat foraging altitude (FWS, 1982) and none of the WBN-related structures occur in major bat flight corridors, such as between roosting caves and reservoir foraging areas. Given this information, TVA and NRC have concluded that the presence of the various WBN structures will not impact bald eagles or gray bats.

Maintenance Impacts. Endangered or threatened species could be impacted if they were present where mechanical or chemical measures are used to maintain WBN-related structures, including transmission lines.

On the WBN site, bald eagles and gray bats are the only listed species likely to be present. They are not likely to be attracted to this built-up area and, therefore, would not be affected by on-site maintenance activities. In the Tennesee River adjacent to WBN, the snail darter and mussel species would not be affected by maintenance chemicals because those chemicals will be routed to holding ponds on site and subjected to periodic toxicity testing before being released to the river. No listed animal or plant species are known to occur on WBN-related transmission line corridors. Maintenance of TVA transmission lines is covered by procedures and instructions in the TVA Transmission Line Maintenance Manual (TVA, 1985 and revisions) and conformance to established best management practices. In addition, each line segment is reviewed for the presence of listed or sensitive species before maintenance activities are performed. On the basis of this information, TVA and NRC have concluded that WBN-related maintenance activities will not impact endangered and threatened animal or plant species.

SUMMARY

All major construction activities at the Tennessee Valley Authority (TVA) Watts Bar Nuclear Plant (WBN) have been completed for some time. TVA is now preparing for the plant to start generating power.

Six current endangered species and one threatened species are now known to exist in the general vicinity of WBN. No additional listed animal or plant species are known to occur on WBN-related transmission line corridors. Five of these species are aquatic (four endangered freshwater mussels and the snail darter, a threatened fish); the other two (bald eagle and gray bat, both endangered) are terrestrial. Regional bald eagle and snail darter populations are increasing, while the gray bat population in this part of its range appears to be relatively stable. All four endangered mussel species found in the Tennessee River adjacent to WBN are represented by relatively few, old individuals. They and most other mussel species present in this area apparently have not reproduced successfully in this part of the Tennessee River during the last 30 or more years.

WBN operational impacts to endangered or threatened aquatic species could occur through the release of radiological, thermal, and/or chemical discharges to the river. Bald eagles and gray bats could be affected if the fish or aquatic insects they prey upon were impacted. Endangered or threatened terrestrial species also could be affected by encounters with the cooling towers, transmission lines, or other structures built as part of the WBN project or with activities and chemicals used to maintain those structures.

Conservative estimates indicate that estimated radiological discharges from WBN would have no impacts on mollusks, fish, or species which prey on them. Monitoring data from the similar, operating Sequoyah Nuclear Plant (40 river miles downstream) found fish and clams showed no increases in the concentrations of a variety of radioactive elements above background levels.

Thermal and chemical discharges from WBN are controlled by a National Pollutant Discharge Elimination System (NPDES) permit. Most discharges would enter the river through a diffuser system located in the river channel; emergency discharges would enter via a drainway along the shore. Modeling studies indicate the maximum predicted temperature rise (under cold weather conditions) would be 1.0°C (1.8°F) while the average temperature rise at the downstream edge of the diffuser or emergency mixing zone would be less than 0.2°C (0.3°F). These temperature increases would not impact endangered or threatened species which live in the river or prey upon aquatic life.

A number of chemicals are used at WBN, including molluscicides to prevent fouling by Asiatic clams. Twelve successive monthly tests have shown that undiluted WBN effluent was not toxic to standard toxicity testing animals (a daphnid, Ceriodaphnia dubia, and fathead minnow, Pimephales promelas). Targeted experiments indicated that this daphnid is much more sensitive to the active ingredients in the molluscicide used at WBN than a fish or two species of juvenile freshwater mussels. When silt is present (a natural condition in the river), the daphnid is at least nine times more sensitive to the molluscicide than the fish or mussels tested. The NPDES permit for WBN requires periodic whole effluent toxicity testing using daphnids as a test organism. This

requirement will provide a very conservative way to ensure that endangered mussel species, the snail darter, and prey of the bald eagle and gray bat are not impacted by these discharges.

The structures on the WBN site and the related transmission lines might result in collisions or other impacts to bald eagles or gray bats. Eagle and gray bat mortality is extremely unlikely from collisions with buildings because eagles see extremely well and bats are adept at avoiding stationary objects. The transmission lines were located to avoid impacts with waterfowl and are marked to minimize impacts with flying objects.

Maintenance of on-site structures and the transmission lines also might impact listed species. Chemicals used for on-site maintenance will be handled in compliance with the NPDES permit. While no listed animal or plant species are known to occur on WBN-related transmission line corridors, maintenance activities in those areas are conducted according to TVA procedures and line segments are reviewed for the presence of listed or sensitive species before the work is performed.

Considered as a whole, operation of WBN is not likely to affect individuals or populations of any endangered or threatened species. While materials in the radioactive, thermal, and chemical discharges from WBN have the potential to impact these species or their prey, adherence to plant procedures and NPDES permit requirements (especially toxicity testing) will ensure that those effects do not occur.

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WMC0289o

Table 1. Summary of added chemicals and resulting end products, Watts Bar Nuclear Plant

Item No.	System	Chemical Treatment Source Chemical and Waste Products	Estimated Maximum Annual Use kg	(lbs)	Waste End Product Chemical	Resulting End Product[a] Average Annual kg	(lbs)	Mean Daily kg	(lbs)
1	Makeup water filter plant	Alum	35,743	(78,800)	$Al(OH)^b$	7,489	(16,510)	20	(45)
					$Al_2(SO_4)_3 \cdot 18H_2O$				
					SO^{2-}	13,880	(30,600)	38	(84)
					Settled Solids[b,c]	32,114	(70,800)	88	(194)
2	Makeup water demineralizer	Sulfuric Acid H_2SO_4 (93% solution)	104,780	(231,000)	SO^{2-} (Neutral pH)	98,430	(217,000)	270	(595)
		Sodium Hydroxide NaOH (50% solution)	195,498	(431,000)	Na^+ (Neutral pH)	56,245	(124,000)	154	(340)
	Natural Minerals Removed by Demineralizers	Sodium Na^+	4,590	(10,120)	Na^+	4,590	(10,120)	13	(28)
		Chloride Cl^-	8,936	(10,700)	Cl	8,936	(10,700)	75	(54)
		Sulfate SO^{2-}	9,866	(21,750)	SO^{2-}	8,866	(21,750)	27	(60)
		Total Dissolved Solids	53,298	(117,500)	Dissolved Solids	53,297	(117,500)	146	(322)
3	Secondary Steam System Condensate Polishing Demineralizers	Sulfuric Acid	267,665	(590,100)	SO^{2-} (Neutral pH)	262,176	(578,000)	717	(1580)
		Sodium Hydroxide NaOH	160,665	(353,500)	Na^+ (Neutral pH)	92,197	(203,260)	254	(560)
	Ionized Soluble Species Removed by Demineralizers	Carbonates (CO^{2-})	11,521	(25,400)	CO^{2-}	11,521	(25,400)	32	(70)
		Metallic Salts	d	d		d	d	d	d
			44,019	(97,820)	Ethanolamine $EtONH_2^+$	44,019	(97,820)	121	(268)
		Boric Acid	45,000	(100,000)	H_3BO_3	45,000	(100,000)	122	(273)

Table 1. (Continued)

Item No.	System	Chemical Treatment Source Chemical and Waste Products	Estimated Maximum Annual Use kg	(lbs)	Waste End Product Chemical	Resulting End Product[a] Average Annual kg	(lbs)	Mean Daily kg	(lbs)
4	Auxiliary Steam Generators	Ammonia NH_3	1.4	(3)[e]	NH_3	1.4	(3)	<.05	(<0.1)
		Hydrazine $H_2N_2H_2$	4.5	(10)[f]	NH_3	4.5	(10)	<.05	(<0.1)
5	Condenser Circulating Water Systems	<<Copper (corrosion product only)[h]			Cu	2,812	(6,200)	8	(17)
		<<Nickel (corrosion product only)[h]			Ni	313	(690)	0.9	(1.9)
6	Raw Cooling Water[g]	Pyrophosphate	34,088	(75,752)	H_2PO^{1-}	34,088	(75,752)	93	(207)
		Organic Co-Polymer Dispersant	7,953	(17,673)	N/A	7,953	(17,673)	22	(48)
		Zinc Sulfate	18,182	(40,405)	Zn^{2+}	7,340	(16,312)	20	(45)
					SO^{2-}	10,841	(24,092)	30	(66)
		Coppertrol	261	(581)	Benzotriazole	261	(581)	22	(48)
		Clamtrol	1,386	(3,080)	DGH	69	(154)	14	(31)
					Quat	110	(246)	22	(49)
		Bromo-Chloro-Hydantoin	3,611	(8,024)	HOCl	1,264	(2,808)	3.5	(7.69)
					HOBR	2,347	(5,216)	6.4	(14.3)
7	Raw Service Water[g]	Pyrophosphate	3,787	(8,417)	H_2PO^{1-}	3,787	(8,417)	10	(23)
		Organic Co-Polymer Dispersant	883	(1,964)	N/A	883	(1,964)	2.4	(5.4)
		Zinc Sulfate	2,020	(4,489)	Zn^{2+}	815	(1,812)	2.3	(5.0)
					SO^{2-}	1,204	(2,677)	3.3	(7.3)
		Coppertrol	29	(65)	Benzotriazole	29	(65)	2.4	(5.3)
		Clamtrol	154	(342)	DGH	8	(17)	1.5	(3.4)
					Quat	12	(27)	2.5	(5.5)
		Bromo-Chloro-Hydantoin	401	(891)	HOCl	140	(312)	0.4	(0.9)
					HOBR	260	(579)	0.7	(1.6)

Table 1. (Continued)

Item No.	System	Chemical Treatment Source Chemical and Waste Products	Estimated Maximum Annual Use kg	(lbs)	Waste End Product Chemical	Resulting End Product[a] Average Annual kg	(lbs)	Mean Daily kg	(lbs)
8	Essential Raw Cooling[g] Water	Pyrophosphate	151,011	(335,581)	H_2PO^{1-}	151,011	(335,581)	413	(919)
		Organic Co-Polymer Dispersant	35,231	(78,291)	N/A	35,231	(78,291)	97	(215)
		Zinc Sulfate	80,547	(178,994)	Zn^{2+}	32,518	(72,262)	89	(198)
					SO^{2-}	48,028	(106,728)	131	(292)
		Coppertrol	1,158	(2,574)	Benzotriazole	1,158	(2,574)	96	(214)
		Clamtrol	6,139	(13,644)	DGH	307	(682)	61	(136)
					QUAT	490	(1,091)	98	(218)
		Bromo-Chloro-Hydantoin	15,996	(35,546)	HOCl	5,598	(12,439)	15	(34)
					HOBR	10,398	(23,107)	28	(63)

a Items 1, 2, 4, 5, 6, 7, and 8 are based on 365 days/year operation at rated capacity. Item 3 based on 292 days/year operation at rated capacity.

b Precipitated material that will make up the water treatment sludge on a day weight basis. Ultimately put in landfill. No discharge.

c Estimates based on maximum suspended solids data observed at TRM 529.9.

d The quantities of ionized soluble species continuously removed by the condensate demineralizers are predicated upon a primary to secondary leak rate or a condenser tube leak. These constituents will be discharged in the form of neutral salts of sodium, oxides of iron, or suspended solids. High crud filters will treat the backwash waste prior to discharge.

e Ammonia will be added as needed to maintain pH of 9.0 in the system.

f Hydrazine will be added as needed as a DO scavenger. Hydrazine conservatively assumed to decompose to ammonia.

g Based on chemical feed rates at maximum cooling water usage and treatment schedule.

h Although copper and nickel will not be added to the system, the values shown represent high estimates of corrosion losses. Actual losses are expected to be immeasurable.

Table 2. Recent endangered mussel records from Watts Bar Dam tailwater. Entries include the total number of each species found during each survey, the River Mile intervals from which they came, and the number found there (if more than one).

Year	*Dromus dromas* dromedary		*Cyprogenia stegaria (= irrorata)* fanshell		*Pleurobema plenum* rough pigtoe		*Lampsilis abrupta (= orbiculata)* pink mucket	
	No.	River Mi.	No.	River Mi.	No.	River Mi.	No.	River Mi.
1978 (random survey)	**3**	520(3)	**4**	520 521(2) 524	**[NR]**		**19**	516 518 520(5) 521(5) 525 527 528(5)
1983	**1**	520	**3**	520 528(2)	**2**	520(2)	**10**	520(2) 526 528(7)
1984			**1**	520	**2**	520(2)	**8**	520 526(3) 528(4)
1985			**1**	520	**1**	528	**8**	520(2) 528(6)
1986							**8**	520(4) 526 528(3)
1988							**12**	526(2) 528(10)
1990							**4**	526 528(3)
1990 (lock survey)							**6**	528(2) 529(4)
1991 (Mead survey)							**2**	525(2)
1992							**6**	526(2) 528(4)

NR - species may have been present but was not recognized.

Table 3. Comparison of estimated annual liquid radioactive releases from Watts Bar Nuclear Plant (WBN) and actual releases from Sequoyah Nuclear Plant (SQN).

	WBN EIS (Table 2.4-2)	WBN FSAR (Table 11.2-7 & Table 11.2-11)	WBN FES (Table 3.3 & Table 5.9)	SQN History (1987-93 Average)	10 CFR 50 Appendix I Guidelines
Tritium Released	1.46E+02 Ci	5.2E+03 Ci	1.04E+03 Ci	8.7E+02 Ci	
Activity Released	3.2E-01 Ci	2.2E+01 Ci	4.4E-01 Ci	4.8E-01 Ci	10 Ci
Total Body Dose	1.7E-02 mrem	1.1E+00 mrem	2.0E-01 mrem	8.0E-02 mrem	3 mrem
Maximum Organ Dose	5.5E-02 mrem	1.3E+00 mrem	1.9E-01 mrem	1.0E-01 mrem	10 mrem

Table 4. Summary of toxicity biomonitoring results fro Watts Bar Nuclear Plant, January 1991 - March 1994

TEST DATE	ORGANISM	CONTROL/ DILUTION	TREATMENT RESPONSE	TREATMENT CONC. (%)	COMMENTS
Jan. 11-18, 1991					Initial baseline test of Outfall 101. Isco composite 24-h samples.
Outfall 101*	*Pimephales promelas*	TR†	Not toxic, s & g§	100, 50	
	Ceriodaphnia dubia	TR	Not toxic, s & r§	100, 50, 25	
	Selenastrum capricornutum	TR	Not toxic, g§	100, 50, 25	
Apr. 9-21, 1991					Test conducted during discharge of ice melt water w/ 2,000 ppm sodium tetraborate (20 gpm). Boron concentration range = 0.22-2.20 mg/L. Also effluent spiked with 9.0 ppm boron (nominal concentration). Isco composite 24-h samples.
Outfall 101*	*Pimephales promelas*	TR	Not toxic, s & g	100, 30, 9, 2.7	9.0 ppm boron not toxic (12-d embryo-larval test).
	Ceriodaphnia dubia	TR	Not toxic, s & r	100, 30, 9, 2.7	9.0 ppm boron toxic (reproduction only)
	Selenastrum capricornutum	TR	Toxic (NOEC = 9%), g	100, 30, 9, 2.7	*Intake source of toxicity*; 9.0 mg B/L was not toxic.
Jul. 31- Aug. 9, 1991					Tested 100% Outfall 101 alone (treatment 2) and with respective high & low concentrations each of: A. TVA06#, TVA07#, Betz 30K# (treatments 3 & 4) B. TVA06, TVA07, Betz 30K, Copper-Trol# (treatments 5 & 6) C. TVA06, TVA07, Betz 30K, Clam-Trol# (treatments 7 & 8) Treatments 5-8 were exposed to Copper-Trol & Clam-Trol only during the initial 24 hours of testing.
Outfall 101*	*Ceriodaphnia dubia*	WBN Intake/ Outfall 101	Acute (24-h) toxicity of treatments 7 & 8 Chronic toxicity of treatments 5 (s) and 3 (r)	See Study Comments	100% mortality in 24-h for treatments 7 & 8. Only high concentrations of A & B affected.

Table 4. (Continued)

TEST DATE	ORGANISM	CONTROL/ DILUTION	TREATMENT		COMMENTS
			RESPONSE	CONC. (%)	
(Cont.)	*Anodonta imbecillis* (Juvenile freshwater mussels, Paper Pondshell, 8-9 days old post transformation, 9-day test exposure)	WBN Intake/ Outfall 101	Not toxic, s	See Study Comments	9-day survival in ranged from 89% (reference) to 98% (treatment 7). All treatments contained ~ 600-800 mg silt/L (dry weight).
Sept. 19-26, 1991 Outfall 101*					Follow up study that Tested 100% Outfall 101 alone (treatment 2) and with respective high & low concentrations each of : A. TVA06, TVA07, Betz 30K (treatments 3 & 4) B. TVA06, TVA07, Betz 30K, Clam-Trol (5 & 6) Treatments 5 & 6 were exposed to CT-1 only during the initial 24 hours of testing.
	Pimephales promelas	WBN Intake/ Outfall 101	Not toxic, s, g	See Study Comments	
	Ceriodaphnia dubia	WBN Intake/ Outfall 101	Acute (24-h) toxicity of treatment 5 and chronic (6-day) toxicity of treatment 6 (s)	See Study Comments	CT-1 toxic at both high and low concentrations tested. No other toxicity observed.
Apr. 9-16, 1992 Outfall 101*					Second baseline evaluation of Outfall 101 alone and spiked w/ Copper-Trol® for the algal test.
	Pimephales promelas	WBN Intake	Toxic (NOEC < 50%), s	100 & 50	*Intake source of toxicity,*
	Ceriodaphnia dubia	WBN Intake	Not toxic, s, r	100, 75, 50, 25	
	Selenastrum capricornutum	WBN Intake	Toxic (NOEC = 50%, IC25 = 63%), g 100%-spiked Outfall 101 not toxic, g	100, 75, 50, 25 Also, with Copper-Trol®-spiked & trsted @ 100, 30, 9	Instream acute and chronic (CMC & CCC) toxicity criteria not exceeded due to dilution (1:83 minimum for the study).

Table 4. (Continued)

TEST DATE	ORGANISM	CONTROL/ DILUTION	TREATMENT		COMMENTS
			RESPONSE	CONC. (%)	
June 25-July 2, 1992					Third baseline assessment of Outfall 101.
Outfall 101*	*Pimephales promelas*	WBN Intake	Not toxic, s, g	100, 50	
	Ceriodaphnia dubia	WBN Intake	Not toxic, s, r	100, 75, 50, 25	
	Selenastrum capricornutum	WBN Intake	Toxic (NOEC = 75%), g	100, 75, 50, 25	Instream acute and chronic (CMC & CCC) toxicity criteria not exceeded due to dilution (1:117 minimum for the study).
Oct. 15-22, 1992					First operational assessment during injection of anti fouling chemicals.
Outfall 101*	*Pimephales promelas*	TR	Not toxic, s, g	100, 50, 25, 12.5	
	Ceriodaphnia dubia	TR	Not toxic, s, r	100, 50, 25, 12.5	
Nov. 18-25, 1992					Second operational assessment during injection of anti fouling chemicals.
Outfall 101*	*Pimephales promelas*	TR	Not toxic, s, g	100, 50, 25, 2	
	Ceriodaphnia dubia	TR	Not toxic, s, r	100, 50, 25, 2	
	Selenastrum capricornutum	TR	Toxic (NOEC = 2%), g	100, 50, 25, 2	Instream acute and chronic (CMC & CCC) toxicity criteria not exceeded due to dilution (1:404 minimum for the study).
Dec. 16-23, 1992					Third operational assessment during injection of anti fouling chemicals.
Outfall 101*	*Pimephales promelas*	Synthetic water	Not toxic, s, g	100, 50, 25, 2	
	Ceriodaphnia dubia	Synthetic water	Not toxic, s, r	100, 50, 25, 2	
Jan. 15-22, 1993					Fourth operational assessment during injection of anti fouling chemicals. *CT-1 injected during study.*
Outfall 101*	*Pimephales promelas*	Synthetic water	Not toxic, s, g	100, 50, 25, 2	
	Ceriodaphnia dubia	Synthetic water	Not toxic, s, r	100, 50, 25, 2	

Table 4. (Continued)

TEST DATE	ORGANISM	CONTROL/ DILUTION	TREATMENT		COMMENTS
			RESPONSE	CONC. (%)	
Feb. 11-18, 1993					Fifth operational assessment during injection of anti fouling chemicals.
Outfall 101*	*Pimephales promelas*	Synthetic water	Not toxic, s, g	100, 50, 25, 2	
	Ceriodaphnia dubia	Synthetic water	Not toxic, s, r	100, 50, 25, 2	
	Selenastrum capricornutum	TR	Toxic (NOEC = 2%), g	100, 50, 25, 2	Instream acute and chronic (CMC & CCC) toxicity criteria not exceeded due to dilution (1:831 minimum for the study).
Mar. 19-26, 1993					Sixth operational assessment during injection of anti fouling chemicals.
Outfall 101*	*Pimephales promelas*	Synthetic water	Not toxic, s, g	100, 50, 25, 2	
	Ceriodaphnia dubia	Synthetic water	Not toxic, s, r	100, 50, 25, 2	
Apr. 16-23, 1993					Seventh operational assessment during injection of anti fouling chemicals.
Outfall 101*	*Pimephales promelas*	Synthetic water	Not toxic, s, g	100, 50, 25, 2	
	Ceriodaphnia dubia	Synthetic water	Not toxic, s, r	100, 50, 25, 2	
May 12-19, 1993					Eighth operational assessment during injection of anti fouling chemicals.
Outfall 101*	*Pimephales promelas*	Synthetic water	Not toxic, s, g	100, 50, 25, 2	
	Ceriodaphnia dubia	Synthetic water	Not toxic, s, r	100, 50, 25, 2	
	Selenastrum capricornutum	Intake/TR	Toxic (NOEC = 2%), g	100, 50, 25, 2	Instream acute and chronic (CMC & CCC) toxicity criteria not exceeded due to dilution (1:159 minimum for the study).
Jun. 9-16, 1993					Ninth operational assessment during injection of anti fouling chemicals.
Outfall 101*	*Pimephales promelas*	Synthetic water	Not toxic, s, g	100, 50, 25, 2	

Table 4. (Continued)

TEST DATE	ORGANISM	CONTROL/ DILUTION	TREATMENT		COMMENTS
			RESPONSE	CONC. (%)	
(Cont.)	*Ceriodaphnia dubia*	Intake/ Synthetic water	Not toxic, s, r	100, 50, 25, 2	
Jul. 15-22, 1993					Tenth operational assessment during injection of anti fouling chemicals.
Outfall 101*	*Pimephales promelas*	Synthetic water	Not toxic, s, g	100, 50, 25, 2	
	Ceriodaphnia dubia	Synthetic water	Not toxic, s, r	100, 50, 25, 2	
Aug. 19-26, 1993					Eleventh operational assessment during injection of anti fouling chemicals.
Outfall 101*	*Pimephales promelas*	Synthetic water	Not toxic, s, g	100, 50, 25, 2	
	Ceriodaphnia dubia	Synthetic water	Not toxic, s, r	100, 50, 25, 2	
	Selenastrum capricornutum	Synthetic water	Toxic (NOEC = 1.1%), g	100, 50, 25, 2	Instream acute and chronic (CMC & CCC) toxicity criteria not exceeded due to dilution (1:424 minimum for the study).
Sep. 25-Oct. 2, 1993					Twelfth operational assessment during injection of anti fouling chemicals. *CT-1 injected during study.*
Outfall 101*	*Pimephales promelas*	Synthetic water	Not toxic, s, g	100, 50, 25, 2	Growth reduction in 25% & 50% treatments but not in undiluted Outfall 101.
	Ceriodaphnia dubia	Synthetic water	Not toxic, s, r	100, 50, 25, 2	
Feb. 2-9, 1994					First semi-annual compliance monitoring of Outfalls 101 and 112 under renewed NPDES permit TN0020168.
Outfall 101*	*Pimephales promelas*	Synthetic water	Not toxic, s, g	100, 9.8, 7.8, 2.9, 2.3	
	Ceriodaphnia dubia	Synthetic water	Toxic (NOEC = 9.8%), r	100, 9.8, 7.8, 2.9, 2.3	*Permit limit not exceeded.*
Outfall 112*	*Pimephales promelas*	Synthetic water	Toxic (NOEC = 25%), s	100, 80, 50, 25, 12.5	*Permit limit exceeded.*

Table 4. (Continued)

TEST DATE	ORGANISM	CONTROL/ DILUTION	TREATMENT		COMMENTS
			RESPONSE	CONC. (%)	
(Cont.)	*Ceriodaphnia dubia*	Synthetic water	Not toxic, s, r	100, 80, 50, 25, 12.5	
Feb. 18-25, 1994					Repeat test of Outfall 112 due to fish toxicity exceeding permit limit.
Outfall 112*	*Pimephales promelas*	Synthetic water	Toxic (NOEC = 25%), g	100, 80, 50, 25, 12.5	*Permit limit exceeded* (based on 0.1 µg of fish weight in 100% Outfall 112 treatment).
	Ceriodaphnia dubia	Synthetic water	Not toxic, s, r	100, 80, 50, 25, 12.5	
Mar. 23-30, 1994					Repeat test due to fish toxicity exceeding permit limit in the previous test.
Outfall 112*	*Pimephales promelas*	Synthetic water	Not toxic, s, g	100, 80, 50, 25, 12.5	
	Ceriodaphnia dubia	Synthetic water	Not toxic, s, r	100, 80, 50, 25, 12.5	

Test types: 3-brood *Ceriodaphnia dubia* chronic test (EPA protocol), 7-day *Pimephales promelas* chronic test (EPA protocol), 9-day *Anodonta imbecillis* acute test (TVA protocol).

*Outfall 101 = Diffuser pipe at TRM 527.9; Outfall 112 = Runoff holding pond to unnamed tributary to Yellow Creek

†TR = Non-toxic dilution water collected from outdoor channels at TVA's Toxicity Testing Laboratory, Wheeler Reservoir once-through water pumped from upstream of the Browns Ferry Nuclear Plant (TRM 293).

§s = survival (fish, daphnids, & mussels), g = growth (fish & algae), r = reproduction (daphnids).

#Chemical additives:

TVA06 = HPS-1 copolymer dispersant
TVA07 = zinc sulfate
Betz 30K = tetra potassium pyro phosphate
Copper-Trol = tolyltriazole
Clam-Trol = CT-1 (DGH/QUAT).

Table 5. DGH/QUAT toxicity to non-target organisms

CT-1 (mg/L)	TOXICITY IN LABORATORY WATER WITHOUT SILT				TOXICITY WITH SILT PRESENT†		
	C. dubia 3-brood test	*P. promelas* 7-day test	*A. imbecillis* 9-day test	*B. calyciflorus.* 24-hour test	*A. imbecillis* 9-day test	*A. imbecillis* 9-day test	*E. angustata* 9-day test
	EMPE* (Survival)	EMPE* (Survival)	TVA* (Survival)	TVA* (Survival)	TVA* (Survival)	PC* (Survival)	PC* (Survival)
Control	NOEC-r (100%)	(100%)	(97.5%)	(100%)	(97.6%)	(97.6%)	(97.5%)
0.05	NOEC-s (100%)						
0.07	96-h LC_{50}						
0.10	(0%)	NOEC-s,g (100%)	(67.5%)	(100%)	(95%)	(87.8%)	(97.5%)
0.12			9-d EC_{50}				
0.14			9-d LC_{50}				
0.20	(0%)						
0.40	(0%)	(85%)	(0%)	(100%)	(97.5%)	(82.5%)	(100%)
0.67		96-h LC_{50}					
0.80	(0%)						
0.96					9-d EC_{50}		
1.07					9-d LC_{50}		
1.60	(0%)	(0%)	(0%)	(60%)	(25%)	(90%)	(97.5%)
1.80§				24-h LC_{50}			
2.85						9-d LC_{50}	
3.20				(0%)			
6.40		(0%)	(0%)	(0%)	(0%)	(0%)	(97.5%)
8.74							9-d LC_{50}
12.80		(0%)	(0%)		(0%)	(0%)	(0%)
26.00					(0%)	(0%)	(0%)

***Testing conducted by EMPE, Inc., Nashville, Tennessee; Tennessee Valley Authority (TVA), Water Management; and Presbyterian College (PC), Clinton, South Carolina. Species tested were < 24-h old *Ceriodaphnia dubia* (daphnids), *Pimephales promelas* (fathead minnows), and *Brachionus calyciflorus* (rotifers), and 8-9 day old *Anodonta imbecillis* and *Elliptio angustata* (freshwater mussels).**

†Silt provided by TVA from non-toxic reference site. Include in test at 600-800 mg dry wt./L.

§Graphically determined.

= Concentration tested. **= Toxicity test endpoint.**

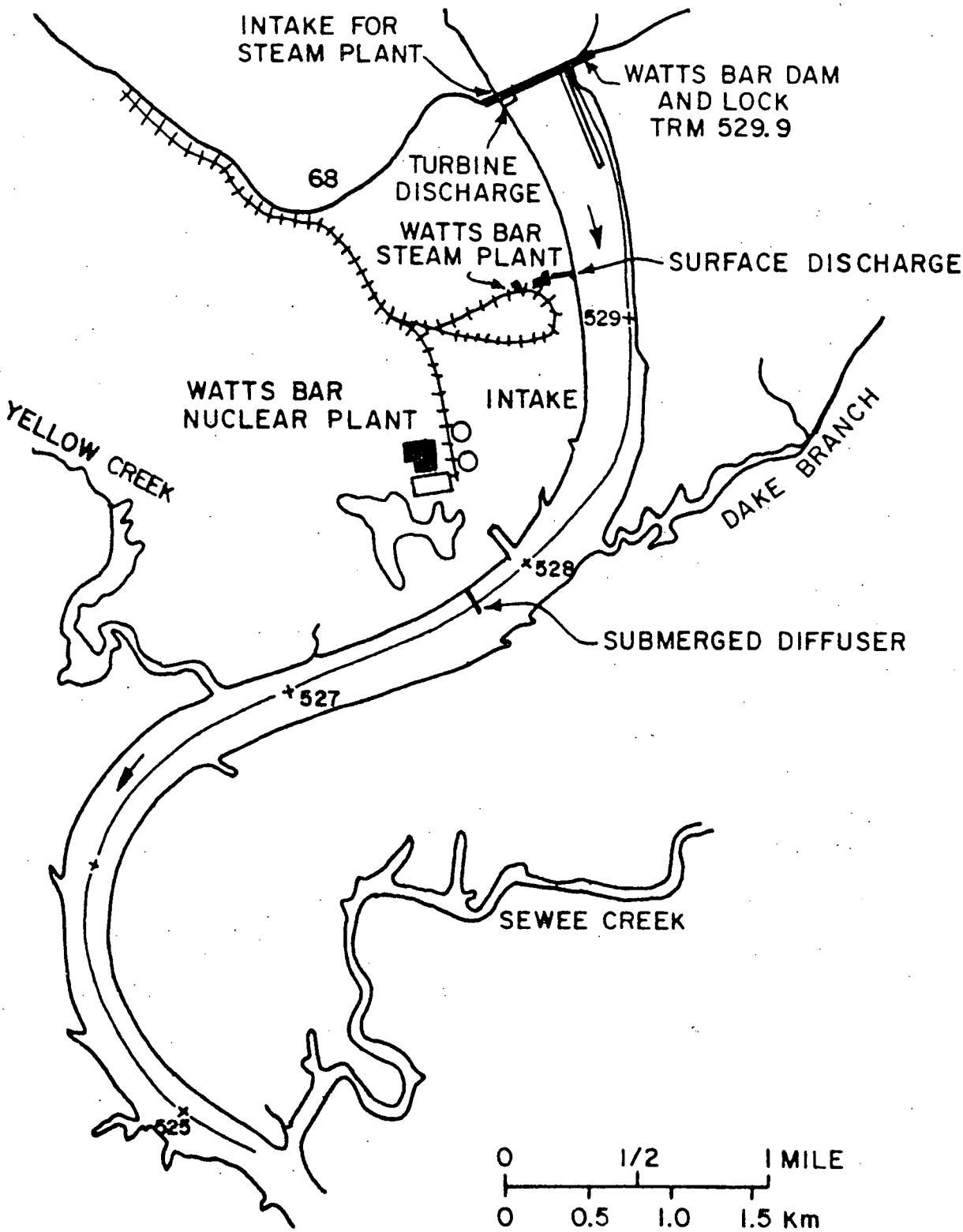

Figure 1. Tennessee River (upper Chickamauga Reservoir), indicating the locations of various facilities associated with the Watts Bar Nuclear Plant

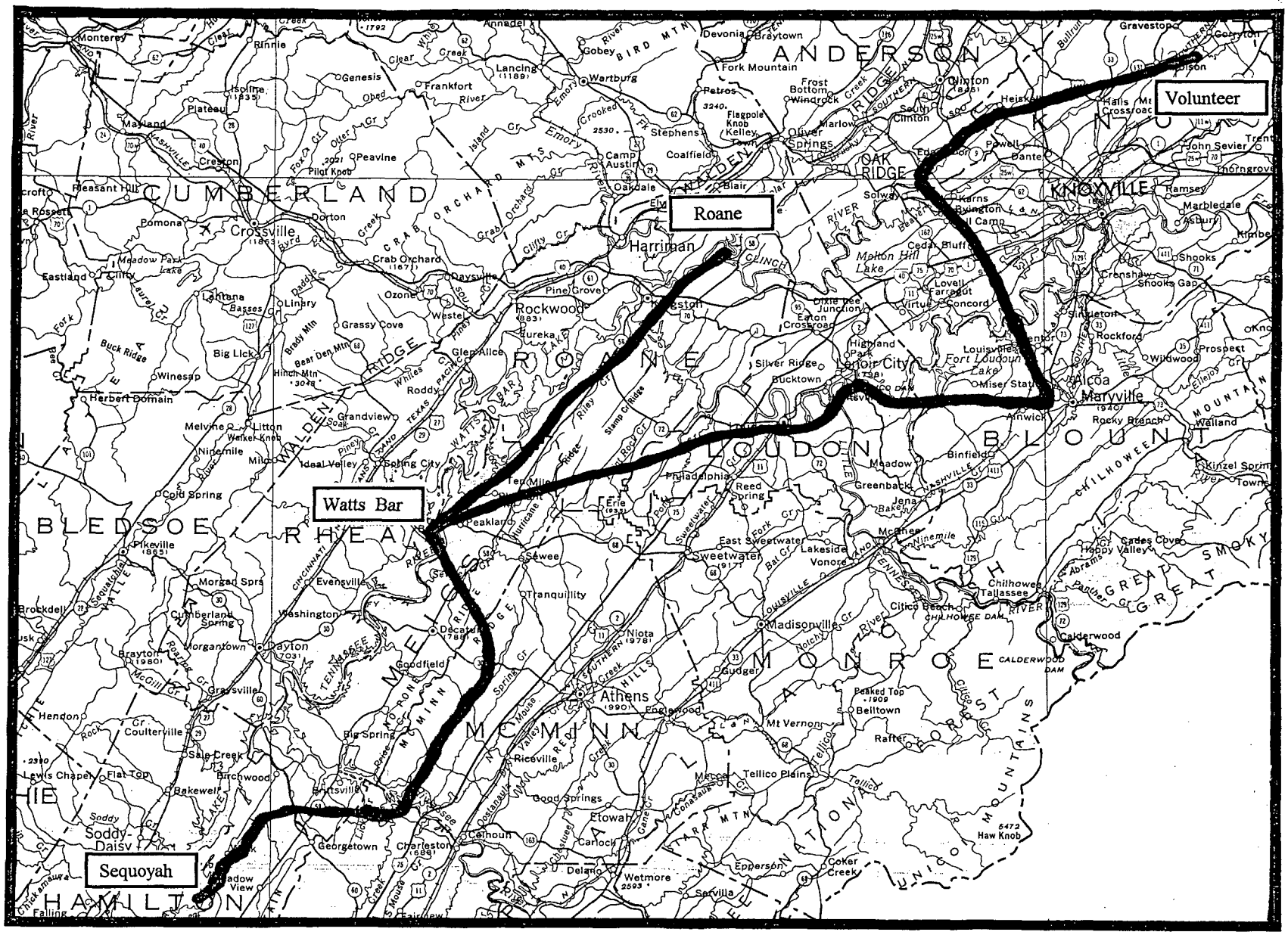

Figure 2. Portion of eastern Tennessee showing the routes of Watts Bar Nuclear Plant-related transmission lines.

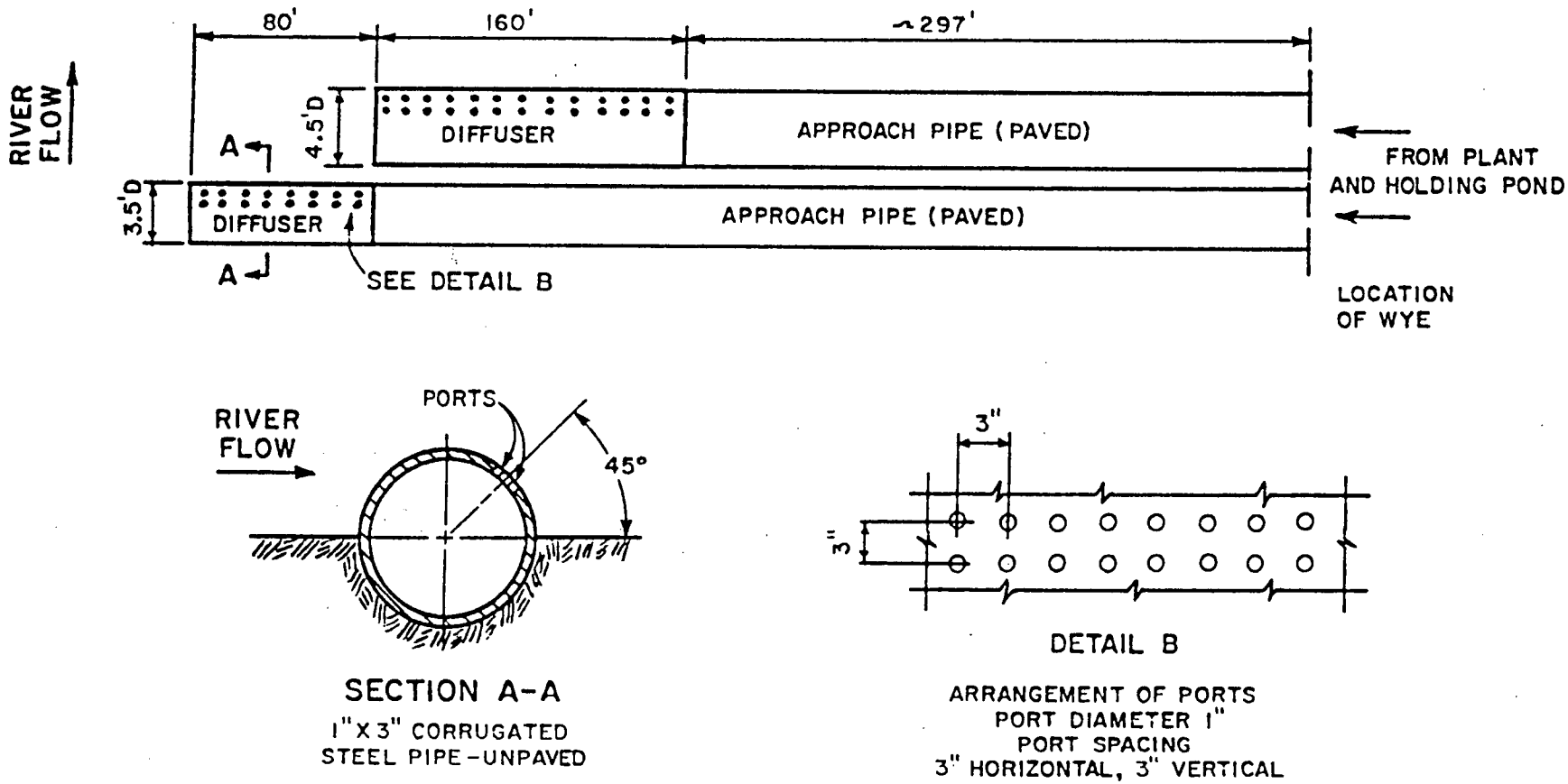

Figure 3. Details of Watts Bar Nuclear Plant multiport diffuser system.

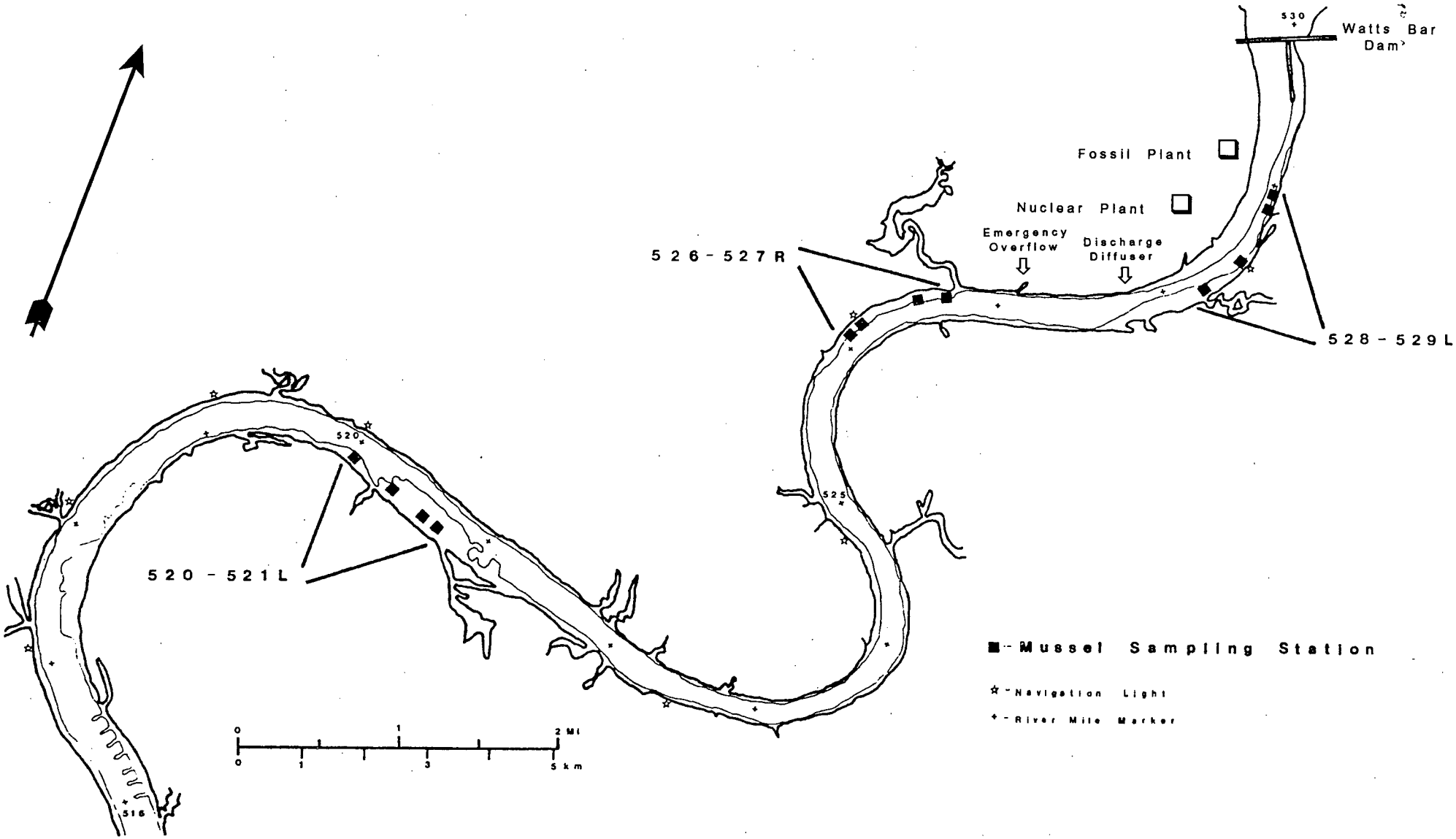

Figure 4. Tennessee River downstream from Watts Bar Dam showing the locations of the three mussel beds and their relationships to the Watts Bar Nuclear Plant discharges.

ENCLOSURE

WATTS BAR NUCLEAR PLANT UNITS 1 AND 2
REQUEST FOR ADDITIONAL INFORMATION ON ENVIRONMENTAL REVIEW

QUESTION 1

Provide a list of Federal, State, and local permits for WBN. Include information regarding the Migratory Bird Treaty Act.

RESPONSE

A list of permits for WBN is attached. TVA has reviewed the Migratory Bird Treaty Act and U.S. Department of Interior's (DOI) implementing regulations and has found nothing which suggests either that a permit must be obtained for possible bird collisions with cooling towers or that the requirements of that Act apply to Federal agencies. TVA does not believe that any requirement of the Act or the implementing regulations require TVA to obtain a permit for possible collisions with WBN's cooling towers and, therefore, do not have such permits.

QUESTION 2

Determine if the Tennessee Health Department is aware of problems with Legionella, or pathogenic amoeba such as Naegleria fowleri in cooling towers within the area.

RESPONSE

Dr. Kerry Gateley, State Epidemiologist with the Tennessee Department of Health said he was aware that conditions in the vicinity of cooling towers could possibly result in exposure to Legionella in mists and aerosols. However, Dr. Gateley is not aware of any cases of disease for which Legionella is the etiological agent having been associated with cooling towers in Tennessee. As for Naegleria, Dr. Gateley was again aware of the theoretical possibility of exposure to the airborne cysts from cooling tower operation, but knew of no cases of this actually happening, and expressed his belief that such a contagion mechanism for Primary Amoebic Meningoencephalitis (PAM) would be highly unlikely.

QUESTION 3

The September 27, 1994, response did not include pages 24, 25, 28, 30, 33, 38, and 46 on ethnic distribution.

RESPONSE

The missing pages 24, 25, 28, 30, 33, 38, and 46 on the ethnic distribution are attached.

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WATTS BAR NUCLEAR PLANT UNITS 1 AND 2
REQUEST FOR ADDITIONAL INFORMATION ON ENVIRONMENTAL REVIEW

QUESTION 4

Provide Section 4 of the census map of Tennessee. This section contains Knox, Blount, and Anderson counties.

RESPONSE

A copy of Section 4 of the Tennessee census map is attached.

Question 5

Provide a copy of the temperature monitoring study sent to the State of Tennessee in December of 1993.

RESPONSE

A copy of the temperature monitoring study sent to the State of Tennessee in December 1993 is attached.

QUESTION 6

The 1978 FES refers to Outfall 005 on page 5.3 (Section 5.3.3 Sanitary Wastes). Was this outfall renumbered (if so please provide the new outfall number), if not where is it located.

RESPONSE

This outfall number referred to an old sand filter sewage treatment system in the early 70s. The current outfall number for the sewage treatment plant is Outfall 111.

QUESTION 7

Is the listing of regional water use in Table 2-2 of the 1978 FES still current? If not please provide an updated table.

RESPONSE

An update of the 1978 FES regional water use table, Table 2-2, is attached.

QUESTION 8

Provide a map of the site with the ponds and outfalls labeled.

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RESPONSE

Maps of the site with the ponds and outfalls labeled are attached.

QUESTION 9

Provide information on method of applying herbicides to vegetation along transmission lines. Is an aerial application process used? Are applicators required to be licensed by the state?

RESPONSE

The lines related to WBN are located in mild to steep rolling terrain that includes some of the ridge and valley geologic province. The lines were constructed and have been maintained for a number of years predominantly by mechanical reclearing. The section of lines to be recleared in the fiscal year 1995 will primarily be by mechanical operations. For sections where herbicides are to be used, a tank mix of accord and arsenal will be used. The method of application will be low volume, utilizing the procedure as described in a section of the Transmission Maintenance Manual in the attachment to this question. As noted in the first paragraph of that procedure, employees making herbicide applications are properly trained in how to use the chemicals. Right-of-Way Program Administrators have restricted use application certifications issued by the State of Tennessee in Category 06 (Right-of-Way Application), and line crew personnel who apply herbicides have private applicator state certifications.

QUESTION 10

Provide a copy of the MSDS for CLAMTROL and COPPERTROL.

RESPONSE

Copies of the MSDS for CLAMTROL and COPPERTROL are attached.

QUESTION 11

The September 27, 1994, response did not include the Fanshell Cyprogenia stergaria, as one of the endangered species. Was this an omission or did the status of this species change.

RESPONSE

The fan-shell should have been included in the September 27, 1994 submittal. This was an inadvertent omission. However, the fan-shell is fully covered in the biological assessment.

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QUESTION 12

The 1978 FES (Section 6.2.5) indicates that a 1 year preoperational aerial remote survey using color infrared and/or multispectral or multiband photography is required as part of the preoperational terrestrial monitoring. Was this performed or was the preoperational monitoring discussed in the April 22, 1980, letter preformed in lieu of the aerial survey?

RESPONSE

Enclosed in the April 22, 1980 letter is a report entitled "Cooling Tower and Steam Plant Plume Mergence at the Watts Bar Site." In Appendix A of that report, Items 3a and 3b discuss the aerial remote survey (pages 34-36). TVA indicated that this remote sensing surveillance program was still experimental and may not prove effective. In lieu of the infrared and/or multispectral or multiband photography, the preoperational monitoring discussed in the April 22, 1980 letter was performed and was acknowledged by the NRC in the draft Appendix B to the Operating License submitted to TVA for review on May 20, 1985.

QUESTION 13

The table on page 5.5-2 of the August 5, 1994, RAI response shows an estimated annual liquid release of 22 curies. The number is based on FSAR Table 11.2-7 and Table 11.2-11. Provide an explanation for why the release is expected to be greater than the 10 CFR 50 Appendix I guidelines, and what type of mitigation plan will be used to ensure that the actual release is below guidelines. Also, provide a copy of the evaluation specified in Section A.3.a of 10 CFR Part 50 Appendix I, which is to include a discussion of the potential for effects from long-term buildup of radioactive material with a radioactive half-life greater than 1 year resulting from liquid effluent release to the environment. This evaluation is required for cases where the liquid effluent releases not including tritium and dissolved gases are projected to exceed the quantity set forth in paragraph A.2 and A.3 of 10 CFR Part 50 Appendix I, guidelines.

RESPONSE

As stated in TVA's letter dated August 19, 1994 concerning FSAR Chapter 11 request for additional information, the values in the FSAR tables are design values that represent the maximum possible release if all effluent streams operated at their maximum values. TVA does not expect to see the values from the FSAR tables for WBN. Releases are expected to be similar to the SQN releases which are considerably smaller.

WBN is committed to maintain releases within 10 CFR 50 Appendix I guidelines. This is accomplished procedurally through sampling of effluent and projecting future doses based on these releases. The following discussion details this process:

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TVA's Offsite Dose Calculation Manual (ODCM), Control 1.2.1.2 states:

> In accordance with WBN TS 5.7.2.7.d and e, the dose or dose commitment to a member of the public from radioactive materials in liquid effluent discharged from each unit to unrestricted areas shall be limited.
>
> a. During any calendar quarter to less than or equal to 1.5 mrem to the total body and to less than or equal to 5 mrem to any organ and,
>
> b. During any calendar year to less than or equal to 3 mrem to the total body and to less than or equal to 10 mrem to any organ.

ODCM Surveillance Requirement 2.2.1.2 states: Cumulative dose contribution from liquid effluent for the current calendar quarter and current calendar year shall be determined in accordance with the methodology and parameters in ODCM Section 6.3 at least once per 31 days.

Additionally, ODCM Control 1.2.1.3 states: in accordance with WBN TS 5.7.2.7f, the liquid radwaste treatment system (LRTS) shall be operable and appropriate portions of the system shall be used to reduce the radioactive materials in liquid wastes prior to their discharge, when the projected doses due to the liquid effluent from each unit to unrestricted areas would exceed 0.06 mrem to the total body or 0.2 mrem to any organ in a 31 day period.

ODCM Surveillance Requirements 2.2.1.3.1 states doses due to liquid releases from each unit to unrestricted areas shall be projected at least once per 31 days, in accordance with the methodology and parameters in ODCM Section 6.5, when the LRTS is not being fully utilized.

The referenced surveillance requirements are implemented by plant procedures which ensure performance of cumulative dose contribution and dose projection calculations prior to each liquid releases based on sampling and analyses described in ODCM Table 2.2.1. If the calculation performed prior to release fails to meet the specified acceptance criteria from the controls, appropriate actions are taken to ensure the release is not performed.

The evaluation of potential effects from long-term buildup of radioactivity is provided in the attachment for this question.

QUESTION 14

Provide the equivalent of Tables 2.3-45 through 2.3-51 from the FSAR giving the frequency of the wind direction and speed for each stability class for the 20 year period (1974-1993).

RESPONSE

The requested tables are provided in the attachment for this question.

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QUESTION 15

Provide the last 5 years (1989-1993) of hourly meteorological data, on a micro-diskette (in ASCII), for Watts Bar in the form outlined in SRP section 2.3.3. Provide an explanation for any significant changes in the last 5 years of data when compared with the previous fifteen years (1974-1988). Discuss whether changes are consistent with meteorological conditions at other locations in the region. Also, describe any changes in the meteorological data collection system and data handling procedures.

RESPONSE

A diskette containing hourly meteorological data for Watts Bar (WBN) in the SRP Section 2.3.3 format was provided separately on October 28, 1994. A description of the tape content and instructions for decompressing the files are included in attachment for this question (Entitled "Meteorological Data" - 3 pages).

Examination of the last 5 years of Watts Bar data compared to the previous 15 years reveals one noteworthy difference. There is a lower average wind speed and related increase in the percent occurrence of calms (defined as wind speeds less than 0.6 mi/h) in the last 5 years. The average wind speed and calm percent occurrence for the last 5 years is 3.6 mi/h and 7.0 percent, respectively. The values for the previous 15 years are 4.2 mi/h and 1.6 percent, respectively.

These values were compared with other locations in the Tennessee Valley region. Other locations included were the Browns Ferry (BFN) and Sequoyah (SQN) Nuclear Plants and the Chattanooga (CHA) and Knoxville (TYS) National Weather Service stations. The results are summarized in attachment for this question in a table entitled "Comparison of Tennessee Valley Region Wind Speed Conditions for 1974-88 and 1989-93" (1 page). Included are the overall mean wind speed, the overall calm percent occurrence (for TVA sites only), and the ratio of the longer-term to 5 year values. The mean wind speed decreased at all sites for the 5 year period by factors ranging from 1.07 for Chattanooga to 1.21 for SQN. The percent frequency of calms increased for the 5 year period at the TVA sites by factors ranging from 3.0 at SQN to 4.4 at WBN. (The calm frequency was not available for the National Weather Service sites). The trend and magnitude of wind condition changes at WBN are considered to be consistent with those in the region.

Changes in the WBN meteorological data collection system and data handling procedures in the 1987 to 1994 period are discussed in the following:

- In February 1987, the wind direction methodology was revised to calculate a vector wind direction and wind speed. However, the arithmetic wind speed calculation was retained and is still used for all WBN FES-related calculations. Proper use of the arithmetic wind speed was verified for these calculations.

- In March 1989, the onsite computer was replaced. Thorough testing indicated no significant differences between data collection methodologies for the old and new systems.

- In October 1991, new strip chart recorders were installed onsite. The strip charts are used in data validation and to replace missing digital data on occasion. Some time was required to become familiar with the new charts for identifying high wind speed threshold problems during data validation.

- Titanium bearings were used in the wind speed anemometers between May and October 1993 and between February and July 1994 in an effort to reduce bearing wear. However, high wind speed threshold problems were detected twice at the 10-meter level during the 1993 period. The hourly data and the strip charts were reviewed to identify suspect data and to delete it from the validated data set.

Throughout this period of data collection at WBN, the system has been operated according to TVA's Quality Assurance Program for Meteorological Monitoring for Nuclear Plants. This program requires semiannual change-out of meteorological sensors with newly-calibrated sensors, daily workday review of onsite meteorological data by qualified individuals to identify problems, and rigorous control of data during the validation and archival process.

QUESTION 16

Provide the following tables for the 15 year period (1974-1988) and for the last 5 years (1989-1993):

1. Wind speed vs. time of day, by month
2. Stability vs. time of day, by month
3. Frequency of calms in the lowest wind sped class by year

Also, provide a professional assessment to support TVA's position that the meteorological data are representative of site conditions and are appropriate for use in dispersion calculations.

RESPONSE

The wind speed vs. time of day, by month, for the 15 year and last 5 years are provided in the attachment for this question in tables entitled "Average Wind Speed (10-M), Watts Bar Nuclear Plant, January 1974-December 1988" (6 pages) and "Average Wind Speed (10-M), Watts Bar Nuclear Plant, January 1989-December 1993" (6 pages). The stability vs. time of day, by month, for the 15 year and last 5 years are provided in the attachment for this question entitled "Average Stability Class Percent Frequency, Watts Bar Nuclear Plant, January 1974-December 1988" (12 pages) and "Average Stability Class Percent Frequency, Watts Bar Nuclear Plant, January 1989-December 1993" (12 pages).

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All references to time in these tables are in Central Time. The frequency of calms table is provided in the attachment to this question entitled "Calm Occurrence (%) By Year For Watts Bar Nuclear Plant" (1 page).

The data in the above tables indicate the expected diurnal and monthly patterns in wind speed and stability class for both the 15 year and last 5 year periods. These consist of:

- lowest wind speeds during the night time hours
- highest average wind speeds in the spring and lowest in the fall seasons
- unstable classes occurring during the daytime and stable classes occurring at night
- less unstable classes during the winter months

The only noteworthy difference noted between the 15 year and latest 5 year period is the lower wind speeds in the last 5 years that was discussed in the response to question 15. This decrease is prevalent throughout the year. Since regional data are consistent with this decrease in wind speed, the WBN data are considered representative of regional conditions. WBN sensor calibration results and annual inspections for compliance with meteorological sitting and exposure criteria indicate no problems with the sensors or exposure.

The relationship of wind speeds and stability class is further examined in a table in the attachment to this question entitled "Comparison of Tennessee Valley Region Average Wind Speed by Stability" (1 page), which compares the average wind speed by stability class for BFN, SQN, and WBN longer-term (i.e., 12-20 years) periods. Highest wind speeds occur with unstable and neutral conditions. SQN and WBN have the highest average wind speeds with A stability conditions. No significant changes are evident in the last 5 years for WBN other than slightly lower wind speeds.

The frequency of calm percent occurrence by year for WBN indicates a trend toward an increasing number of calms at 10 meters, especially since 1987. An unusually high calm occurrence is evident in 1993 for both the 10 and 46 meter levels. This may be partly attributable to the high threshold problems encountered with the titanium bearings in 1993 discussed in the answer to Question 15. The calm occurrence at 10 meters for the first six months of 1994 has decreased to about 7 percent.

In summary, WBN data for the 1974-1993 period are consistent with other sites in the region, encompass climate variations expected during a 20-year period, and have been collected and maintained in a quality manner. Therefore, the 20-year WBN data base is considered representative of the WBN site and suitable for dispersion calculations.

ENCLOSURE

WATTS BAR NUCLEAR PLANT UNITS 1 AND 2
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QUESTION 17

If available, provide a STAR analysis for any facility in the vicinity of WBN. Provide a STAR analysis using data that is concurrent with an equivalent delta-T analysis.

RESPONSE

The table in the attachment for this question entitled "Frequency Distribution Knoxville, Tennessee, Jan 1, 1992-December 31, 1992" (9 pages) provides a STAR analysis for 1992 for the Knoxville National Weather Service Station, which is located about 47 miles east-northeast of WBN. A WBN joint frequency distribution for the concurrent period with the delta-T approach for stability class determination is provided in the table in the attachment to this question entitled "Joint Percentage Frequencies of Wind Speed by Wind Direction for Stability Class A through Class G" (7 pages), "Joint Percentage Frequencies of Wind Speed by Wind Direction Disregarding Stability Class" (1 page), and "Joint Percentage Frequencies of Wind Speed by Stability Class." Note that the STAR analysis is presented as a frequency while the WBN summary is presented as percent.

QUESTION 18

Provide 1992 populations estimates for the following counties: (Blount County added informally from a teleconference with S. Flanders on October 31, 1994).

1. Anderson
2. Bledsoe
3. Blount
4. Cumberland
5. Knox
6. Morgan
7. Polk
8. Sequatchie

RESPONSE 18

The 1992 population estimates for the counties questioned are listed below:

POPULATION ESTIMATES, 1992

COUNTY(TN)	POPULATION
Anderson	70,525
Bledsoe	9,779
Blount	90,400
Cumberland	36,743
Knox	347,583
Morgan	17,714
Polk	13,903
Sequatchie	9,186

Source: U.S. Bureau of the Census.

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(The next three questions are from the teleconference on October 31, 1994.)

QUESTION 19

Are the transmission line designs based on the National Electrical Safety Code (NESC) which requires that transmission lines be designed so that the short-circuit current to ground produced from the largest anticipated vehicle or object under the lines is limited to less than 6 milliamperes?

RESPONSE

The design criteria for TVA transmission lines is a minimum clearance above ground which varies depending upon the underlying land use. For example, the minimum clearance over pasture or crop land is 25 feet for 161-kV and 30 feet for 500-kV while the clearance over interstate highways is 35 feet for 161-kV and 40 feet for 500-kV. These minimum clearances exceed the requirements of the National Electrical Safety Code. For 161-kV lines, the induced charge/short circuit current is less than 5 milliamps for the largest anticipated vehicle. For 500-kV lines, the induced charge/short circuit current is less than 5 milliamps for the largest vehicle normally expected to be present including farm equipment. A 5 milliamps short circuit current could be exceeded if a large vehicle such as a tractor-trailer exceeding about 13.5 feet in height were parked under a 500-kV line with 30-foot clearance. TVA's practice is to increase clearance over areas where such vehicles could reasonably be expected to be present such as interstate highways, other major roads, large parking lots, etc.

QUESTION 20

Is the information in the NRC's 1978 FES-OL regarding the anticipated maximum groundwater consumption (potable water) after startup still 1140 cubic meters (300,000) gallons per day?

RESPONSE

The information in the NRC's 1978 FES-OL regarding the anticipated maximum groundwater consumption after startup is still accurate.

QUESTION 21

Your Chemistry Manual, Chapter 4.02, Rev. 3, Section 3.0 (Precautions and Limitations - E, F, and G refers to a "letter of agreement with the State of Tennessee." Is this the same as the NPDES permit? If it is a separate document, we would be interested in obtaining a copy.

RESPONSE

The referenced letter of agreement refers to a letter received from the State

of Tennessee (see attachment to this question) that approved the initial injection of raw water treatment chemicals on a trial basis. During the trial period, toxicity testing was to be conducted and results reported to the State. The State would then determine if further reporting would be necessary.

The toxicity monitoring was conducted from October 1992 through September 1993 and the results submitted to the State. The State then reviewed the results and issued the revised NPDES permit effective December 1993. The toxicity results were provided to the NRC during the July 27, 1994 environmental information audit and submitted in a letter dated August 26, 1994.

ATTACHMENT

Question 1

WBN ENVIRONMENTAL PERMIT STATUS

SOURCE	PERMIT NUMBER	RENEWAL DATE	EXPIRATION DATE
NPDES	TN0020168	03/29/98	09/29/98
STORMWATER	TNR001343	03/26/97	09/26/97
PAINT SHOP	037348P	07/01/97	09/01/97
COOLING TOWER 1	019953P	NONE	NONE
COOLING TOWER 2	019954P	NONE	NONE
GASOLINE STORAGE TANK	032600P	07/01/95	09/01/95
FUEL OIL TANKS	033969P	07/01/96	09/01/96
SANDBLAST SHOP	037347P	07/01/97	09/01/97
LUBE OIL TANK 1	029535P	07/01/95	09/01/95
LUBE OIL TANK 2	029536P	07/01/95	09/01/95
LANDFILL (FEES ONLY)	721030025	09/01/95	10/01/95
DIESEL GEN UST (FEES ONLY)	0-610035	02/31/95	03/31/95
AUXILIARY BOILERS	035170F	08/01/97	10/01/97
HAZARDOUS WASTE (FEES)	2640030035	02/01/95	03/01/95

09/01/94 VJS

ATTACHMENT

Question 3

Table 6. Race and Hispanic Origin: 1990—Con.

[For definitions of terms and meanings of symbols, see text]

Place and [In Selected States] County Subdivision [1,000 or More Persons]	Baxter town	Bellevue City CDP	Belle Meade city	Bells town	Bristol city	Bloomingdale CDP	Blountville CDP	Bluff City city	Bolivar city	Bradford town
RACE										
All persons	1 289	2 098	2 839	1 643	1 326	10 953	2 605	1 390	5 969	1 154
White	1 284	1 963	2 813	1 155	1 303	10 889	2 571	1 363	3 020	1 064
Black	2	95	14	482	18	27	28	21	2 905	90
American Indian, Eskimo, or Aleut	-	12	1	1	2	7	1	3	6	-
American Indian	-	12	1	1	2	7	1	3	6	-
Eskimo	-	-	-	-	-	-	-	-	-	-
Aleut	-	-	-	-	-	-	-	-	-	-
Asian or Pacific Islander	3	17	10	-	2	21	5	3	37	-
Asian	3	15	10	-	2	21	4	3	37	-
Chinese	-	3	4	-	-	2	-	1	-	-
Filipino	-	6	4	-	-	3	3	2	11	-
Japanese	1	1	-	-	-	3	1	-	1	-
Asian Indian	-	1	-	-	-	3	-	-	24	-
Korean	-	-	2	-	2	-	-	-	-	-
Vietnamese	-	-	-	-	-	4	-	-	-	-
Cambodian	-	-	-	-	-	-	-	-	-	-
Hmong	-	-	-	-	-	-	-	-	-	-
Laotian	-	-	-	-	-	-	-	-	-	-
Thai	-	4	-	-	-	-	-	-	1	-
Other Asian	2	-	-	-	-	6	-	-	-	-
Bangladeshi	-	-	-	-	-	-	-	-	-	-
Burmese	-	-	-	-	-	-	-	-	-	-
Indonesian	-	-	-	-	-	-	-	-	-	-
Malayan	-	-	-	-	-	-	-	-	-	-
Okinawan	-	-	-	-	-	-	-	-	-	-
Pakistani	-	-	-	-	-	-	-	-	-	-
Sri Lankan	-	-	-	-	-	-	-	-	-	-
All other Asian	2	-	-	-	-	6	-	-	-	-
Pacific Islander	-	2	-	-	-	-	1	-	-	-
Hawaiian	-	-	-	-	-	-	1	-	-	-
Samoan	-	-	-	-	-	-	-	-	-	-
Guamanian	-	2	-	-	-	-	-	-	-	-
Other Pacific Islander	-	-	-	-	-	-	-	-	-	-
Tongan	-	-	-	-	-	-	-	-	-	-
Tahitian	-	-	-	-	-	-	-	-	-	-
Northern Marianas Islander	-	-	-	-	-	-	-	-	-	-
Palauan	-	-	-	-	-	-	-	-	-	-
Fijian	-	-	-	-	-	-	-	-	-	-
All other Pacific Islander	-	-	-	-	-	-	-	-	-	-
Other race	-	11	1	5	1	9	-	-	1	-
HISPANIC ORIGIN										
All persons	1 289	2 098	2 839	1 643	1 326	10 953	2 605	1 390	5 969	1 154
Hispanic origin (of any race)	4	42	5	14	4	35	6	1	100	2
Mexican	3	20	3	10	1	12	2	1	8	2
Puerto Rican	1	2	-	-	-	3	-	-	5	-
Cuban	-	-	2	-	-	3	2	-	1	-
Other Hispanic	-	20	-	4	3	17	2	-	86	-
Not of Hispanic origin	1 285	2 056	2 834	1 629	1 322	10 918	2 599	1 389	5 869	1 152
RACE AND HISPANIC ORIGIN										
All persons	1 289	2 098	2 839	1 643	1 326	10 953	2 605	1 390	5 969	1 154
White	1 284	1 963	2 813	1 155	1 303	10 889	2 571	1 363	3 020	1 064
Hispanic origin	4	29	3	9	3	25	5	1	86	2
Not of Hispanic origin	1 280	1 934	2 810	1 146	1 300	10 864	2 566	1 362	2 934	1 062
Black	2	95	14	482	18	27	28	21	2 905	90
Hispanic origin	-	-	1	-	-	-	1	-	8	-
Not of Hispanic origin	2	95	13	482	18	27	27	21	2 897	90
American Indian, Eskimo, or Aleut	-	12	1	1	2	7	1	3	6	-
Hispanic origin	-	2	-	-	-	-	-	-	2	-
Not of Hispanic origin	-	10	1	1	2	7	1	3	4	-
Asian or Pacific Islander	3	17	10	-	2	21	5	3	37	-
Hispanic origin	-	-	-	-	-	1	-	-	3	-
Not of Hispanic origin	3	17	10	-	2	20	5	3	34	-
Other race	-	11	1	5	1	9	-	-	1	-
Hispanic origin	-	11	1	5	1	9	-	-	1	-
Not of Hispanic origin	-	-	-	-	-	-	-	-	-	-
PERCENT DISTRIBUTION BY RACE										
All persons	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
White	99.6	93.6	99.1	70.3	98.3	99.4	98.7	98.1	50.6	92.2
Black	.2	4.5	.5	29.3	1.4	.2	1.1	1.5	48.7	7.8
American Indian, Eskimo, or Aleut	-	.6	-	.1	.2	.1	-	.2	.1	-
American Indian	-	.6	-	.1	.2	.1	-	.2	.1	-
Asian or Pacific Islander	.2	.8	.4	-	.2	.2	.2	.2	.6	-
Asian	.2	.7	.4	-	.2	.2	.2	.2	.6	-
Pacific Islander	-	.1	-	-	-	-	-	-	-	-
Other race	-	.5	-	.3	.1	.1	-	-	-	-
PERCENT DISTRIBUTION BY HISPANIC ORIGIN										
All persons	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Hispanic origin (of any race)	.3	2.0	.2	.9	.3	.3	.2	.1	1.7	.2
Mexican	.2	1.0	.1	.6	.1	.1	.1	.1	.1	.2
Puerto Rican	.1	.1	-	-	-	-	-	-	.1	-
Cuban	-	-	.1	-	-	-	.1	-	-	-
Other Hispanic	-	1.0	-	.2	.2	.2	.1	-	1.4	-
Not of Hispanic origin	99.7	98.0	99.8	99.1	99.7	99.7	99.8	99.9	98.3	99.8
PERCENT WHITE, NOT OF HISPANIC ORIGIN										
All persons	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
White	99.6	93.6	99.1	70.3	98.3	99.4	98.7	98.1	50.6	92.2
Not of Hispanic origin	99.3	92.2	99.0	69.8	98.0	99.2	98.5	98.0	49.2	92.0

Table 6. Race and Hispanic Origin: 1990—Con.

(For definitions of terms and meanings of symbols, see text)

Place and [In Selected States] County Subdivision [1,000 or More Persons]	Brentwood city	Bristol city	Brownsville city	Bruceton town	Burns town	Camden town	Carthage town	Caryville town	Celina town	Centerville town
RACE										
All persons	16 392	23 421	10 019	1 586	1 127	3 643	2 386	1 751	1 493	3 616
White	15 894	22 390	4 606	1 548	1 097	3 438	2 192	1 733	1 474	3 393
Black	260	685	5 359	33	23	186	188	3	9	215
American Indian, Eskimo, or Aleut	15	186	12	4	3	2	–	5	6	7
American Indian	15	185	10	4	3	2	–	5	6	7
Eskimo	–	1	2	–	–	–	–	–	–	–
Aleut	–	–	–	–	–	–	–	–	–	–
Asian or Pacific Islander	213	120	16	1	–	10	5	10	2	1
Asian	213	120	14	1	–	10	5	10	2	1
Chinese	28	22	4	–	–	–	–	4	–	–
Filipino	3	12	7	–	–	7	–	1	2	1
Japanese	83	6	1	–	–	1	–	–	–	–
Asian Indian	74	43	–	–	–	1	4	5	–	–
Korean	19	22	2	1	–	–	1	–	–	–
Vietnamese	1	8	–	–	–	1	–	–	–	–
Cambodian	–	–	–	–	–	–	–	–	–	–
Hmong	–	–	–	–	–	–	–	–	–	–
Laotian	–	6	–	–	–	–	–	–	–	–
Thai	1	1	–	–	–	–	–	–	–	–
Other Asian	4	–	–	–	–	–	–	–	–	–
Bangladeshi	–	–	–	–	–	–	–	–	–	–
Burmese	–	–	–	–	–	–	–	–	–	–
Indonesian	–	–	–	–	–	–	–	–	–	–
Malaysian	–	–	–	–	–	–	–	–	–	–
Okinawan	–	–	–	–	–	–	–	–	–	–
Pakistani	–	–	–	–	–	–	–	–	–	–
Sri Lankan	–	–	–	–	–	–	–	–	–	–
All other Asian	4	–	–	–	–	–	–	–	–	–
Pacific Islander	–	–	2	–	–	–	–	–	–	–
Hawaiian	–	–	2	–	–	–	–	–	–	–
Samoan	–	–	–	–	–	–	–	–	–	–
Guamanian	–	–	–	–	–	–	–	–	–	–
Other Pacific Islander	–	–	–	–	–	–	–	–	–	–
Tongan	–	–	–	–	–	–	–	–	–	–
Tahitian	–	–	–	–	–	–	–	–	–	–
Northern Mariana Islander	–	–	–	–	–	–	–	–	–	–
Polynesian	–	–	–	–	–	–	–	–	–	–
Fijian	–	–	–	–	–	–	–	–	–	–
All other Pacific Islander	–	–	–	–	–	–	–	–	–	–
Other race	10	40	26	–	4	7	1	–	2	–
HISPANIC ORIGIN										
All persons	16 392	23 421	10 019	1 586	1 127	3 643	2 386	1 751	1 493	3 616
Hispanic origin (of any race)	82	158	70	4	15	20	19	1	6	12
Mexican	20	68	53	–	12	17	–	1	4	6
Puerto Rican	8	45	1	–	–	1	1	–	–	–
Cuban	6	7	2	–	–	–	–	–	–	–
Other Hispanic	48	38	14	4	3	2	18	–	2	6
Not of Hispanic origin	16 310	23 263	9 949	1 582	1 112	3 623	2 367	1 750	1 487	3 604
RACE AND HISPANIC ORIGIN										
All persons	16 392	23 421	10 019	1 586	1 127	3 643	2 386	1 751	1 493	3 616
White	15 894	22 390	4 606	1 548	1 097	3 438	2 192	1 733	1 474	3 393
Hispanic origin	73	107	23	3	11	16	13	–	2	12
Not of Hispanic origin	15 821	22 283	4 583	1 545	1 086	3 422	2 178	1 733	1 472	3 381
Black	260	685	5 359	33	23	186	188	3	9	215
Hispanic origin	–	4	16	–	–	–	–	–	–	–
Not of Hispanic origin	260	681	5 343	33	23	186	188	3	9	215
American Indian, Eskimo, or Aleut	15	186	12	4	3	2	–	5	6	7
Hispanic origin	–	6	–	–	–	–	–	–	–	–
Not of Hispanic origin	15	180	12	4	3	2	–	5	6	7
Asian or Pacific Islander	213	120	16	1	–	10	5	10	2	1
Hispanic origin	2	2	6	1	–	–	4	1	2	–
Not of Hispanic origin	211	118	10	–	–	10	1	9	–	1
Other race	10	40	26	–	4	7	1	–	2	–
Hispanic origin	7	39	25	–	4	4	1	–	2	–
Not of Hispanic origin	3	1	1	–	–	3	–	–	–	–
PERCENT DISTRIBUTION BY RACE										
All persons	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
White	97.0	95.6	46.0	97.6	97.3	94.4	91.9	99.0	98.7	93.8
Black	1.6	2.9	53.5	2.1	2.0	5.1	7.9	.2	.6	5.9
American Indian, Eskimo, or Aleut	.1	.8	.1	.3	.3	.1	–	.3	.4	.2
American Indian	.1	.8	.1	.3	.3	.1	–	.3	.4	.2
Asian or Pacific Islander	1.3	.5	.2	.1	–	.3	.2	.6	.1	–
Asian	1.3	.5	.1	.1	–	.3	.2	.6	.1	–
Pacific Islander	–	–	–	–	–	–	–	–	–	–
Other race	.1	.2	.3	–	.4	.2	–	–	.1	–
PERCENT DISTRIBUTION BY HISPANIC ORIGIN										
All persons	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Hispanic origin (of any race)	.5	.7	.7	.3	1.3	.5	.2	.1	.4	.3
Mexican	.1	.3	.5	–	1.1	.5	–	.1	.3	.2
Puerto Rican	–	.2	–	–	–	–	–	–	–	–
Cuban	–	–	–	–	–	–	–	–	–	–
Other Hispanic	.3	.2	.1	.3	.3	.1	.8	–	.1	.2
Not of Hispanic origin	99.5	99.3	99.3	99.7	98.7	99.5	99.2	99.9	99.6	99.7
PERCENT WHITE, NOT OF HISPANIC ORIGIN										
All persons	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
White	97.0	95.6	46.0	97.6	97.3	94.4	91.9	99.0	98.7	93.8
Not of Hispanic origin	96.5	95.1	45.7	97.4	96.4	93.9	91.3	99.0	98.6	93.5

Table 6. Race and Hispanic Origin: 1990—Con.

[For definitions of terms and meanings of symbols, see text]

Place and [In Selected States] County Subdivision [1,000 or More Persons]	Decherd town	Dickson city	Dover city	Dresden town	Dunlap city	Dyer city	Dyersburg city	Eagleton Village CDP	East Brainerd CDP	East Cleveland CDP
RACE										
All persons	2 196	8 791	1 341	2 488	3 731	2 204	16 317	5 169	11 594	1 249
White	1 895	7 881	1 279	2 354	3 724	1 878	13 073	5 099	10 788	1 216
Black	292	829	51	126	2	321	3 153	35	665	26
American Indian, Eskimo, or Aleut	5	20	5	2	2	1	29	21	20	7
American Indian	5	20	5	2	2	1	29	21	20	7
Eskimo	-	-	-	-	-	-	-	-	-	-
Aleut	-	-	-	-	-	-	-	-	-	-
Asian or Pacific Islander	4	37	4	5	2	2	43	11	93	-
Asian	3	37	3	5	1	1	43	11	92	-
Chinese	-	5	-	-	-	-	6	-	13	-
Filipino	-	2	2	-	1	1	1	6	10	-
Japanese	2	19	-	-	-	-	11	-	10	-
Asian Indian	-	8	-	5	-	-	15	-	27	-
Korean	-	3	1	-	-	-	6	-	22	-
Vietnamese	-	-	-	-	-	-	-	-	2	-
Cambodian	-	-	-	-	-	-	-	-	1	-
Hmong	-	-	-	-	-	-	-	-	-	-
Laotian	-	-	-	-	-	-	-	-	-	-
Thai	-	-	-	-	-	-	-	-	-	-
Other Asian	-	-	-	-	-	-	4	5	7	-
Bangladeshi	-	-	-	-	-	-	-	-	-	-
Burmese	-	-	-	-	-	-	-	1	-	-
Indonesian	-	-	-	-	-	-	-	-	-	-
Malayan	-	-	-	-	-	-	-	-	-	-
Okinawan	-	-	-	-	-	-	-	-	-	-
Pakistani	-	-	-	-	-	-	-	2	5	-
Sri Lankan	-	-	-	-	-	-	-	-	-	-
All other Asian	-	-	-	-	-	-	4	2	2	-
Pacific Islander	1	-	1	-	1	1	-	-	1	-
Hawaiian	1	-	-	-	1	1	-	-	-	-
Samoan	-	-	1	-	-	-	-	-	-	-
Guamanian	-	-	-	-	-	-	-	-	-	-
Other Pacific Islander	-	-	-	-	-	-	-	-	1	-
Tongan	-	-	-	-	-	-	-	-	-	-
Tahitian	-	-	-	-	-	-	-	-	1	-
Northern Mariana Islander	-	-	-	-	-	-	-	-	-	-
Palauan	-	-	-	-	-	-	-	-	-	-
Fijian	-	-	-	-	-	-	-	-	-	-
All other Pacific Islander	-	-	-	-	-	-	-	-	-	-
Other race	-	24	2	1	1	2	19	3	28	-
HISPANIC ORIGIN										
All persons	2 196	8 791	1 341	2 488	3 731	2 204	16 317	5 169	11 594	1 249
Hispanic origin (of any race)	5	63	5	13	15	7	72	16	86	24
Mexican	2	30	3	1	3	5	23	6	22	12
Puerto Rican	-	11	-	2	-	-	6	1	16	-
Cuban	2	4	-	-	-	-	2	1	6	-
Other Hispanic	1	18	2	10	12	2	41	8	42	12
Not of Hispanic origin	2 191	8 728	1 336	2 475	3 716	2 197	16 245	5 153	11 508	1 225
RACE AND HISPANIC ORIGIN										
All persons	2 196	8 791	1 341	2 488	2 731	2 204	16 317	5 169	11 594	1 249
White	1 895	7 881	1 279	2 354	3 724	1 878	13 073	5 099	10 788	1 216
Hispanic origin	5	36	3	12	14	5	46	13	58	24
Not of Hispanic origin	1 890	7 845	1 276	2 342	3 710	1 873	13 027	5 086	10 730	1 192
Black	292	829	51	126	2	321	3 153	35	665	26
Hispanic origin	-	-	-	-	-	-	6	-	3	-
Not of Hispanic origin	292	829	51	126	2	321	3 147	35	662	26
American Indian, Eskimo, or Aleut	5	20	5	2	2	1	29	21	20	7
Hispanic origin	-	4	-	-	-	-	1	-	-	-
Not of Hispanic origin	5	16	5	2	2	1	28	21	20	7
Asian or Pacific Islander	4	37	4	5	2	2	43	11	93	-
Hispanic origin	-	-	-	-	-	-	5	-	-	-
Not of Hispanic origin	4	37	4	5	2	2	38	11	93	-
Other race	-	24	2	1	1	2	19	3	28	-
Hispanic origin	-	23	2	1	1	2	14	3	25	-
Not of Hispanic origin	-	1	-	-	-	-	5	-	3	-
PERCENT DISTRIBUTION BY RACE										
All persons	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
White	86.3	89.6	95.4	94.6	99.8	85.2	80.1	98.6	93.0	97.4
Black	13.3	9.4	3.8	5.1	.1	14.6	19.3	.7	5.7	2.1
American Indian, Eskimo, or Aleut	.2	.2	.4	.1	.1	-	.2	.4	.2	.6
American Indian	.2	.2	.4	.1	.1	-	.2	.4	.2	.6
Asian or Pacific Islander	.2	.4	.3	.2	.1	.1	.3	.2	.8	-
Asian	.1	.4	.2	.2	-	-	.3	.2	.8	-
Pacific Islander	-	-	.1	-	-	-	-	-	-	-
Other race	-	.3	.1	-	-	.1	.1	.1	.2	-
PERCENT DISTRIBUTION BY HISPANIC ORIGIN										
All persons	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Hispanic origin (of any race)	.2	.7	.4	.5	.4	.3	.4	.3	.7	1.9
Mexican	.1	.3	.2	-	.1	.2	.1	.1	.2	1.0
Puerto Rican	-	.1	-	.1	-	-	-	-	.1	-
Cuban	.1	-	-	-	-	-	-	-	.1	-
Other Hispanic	-	.2	.1	.4	.3	.1	.3	.2	.4	1.0
Not of Hispanic origin	99.8	99.3	99.6	99.5	99.6	99.7	99.6	99.7	99.3	98.1
PERCENT WHITE, NOT OF HISPANIC ORIGIN										
All persons	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
White	86.3	89.6	95.4	94.6	99.8	85.2	80.1	98.6	93.0	97.4
Not of Hispanic origin	86.1	89.2	95.2	94.1	99.4	85.0	79.8	98.4	92.5	95.4

Table 6. Race and Hispanic Origin: 1990—Con.

[For definitions of terms and meanings of symbols, see text]

Place and [in Selected States] County Subdivision [1,000 or More Persons]	Fall Branch CDP	Farragut town	Fayetteville city	Forest Hills city	Franklin city	Gainesboro town	Gallatin city	Gatlinburg city	Germantown city	Gleason town
RACE										
All persons	1 203	12 793	6 921	4 231	20 098	1 002	18 794	3 417	32 893	1 402
White	1 201	12 242	5 037	4 133	16 289	989	15 107	3 363	31 299	1 391
Black	-	181	1 838	38	3 615	2	3 594	2	610	9
American Indian, Eskimo, or Aleut	2	18	7	2	36	1	26	13	63	1
American Indian	2	18	7	2	36	1	26	13	45	1
Eskimo	-	-	-	-	-	-	-	-	-	-
Aleut	-	-	-	-	-	-	-	-	18	-
Asian or Pacific Islander	-	322	26	57	103	10	51	38	894	1
Asian	-	322	25	56	99	10	48	38	890	1
Chinese	-	91	-	10	21	-	12	5	217	-
Filipino	-	11	-	1	13	-	6	-	20	-
Japanese	-	34	1	15	9	-	1	1	116	-
Asian Indian	-	147	20	16	24	5	9	27	307	-
Korean	-	17	-	9	13	5	12	-	141	1
Vietnamese	-	4	-	4	1	-	5	-	52	-
Cambodian	-	-	-	-	-	-	-	-	-	-
Hmong	-	-	-	-	-	-	-	-	-	-
Laotian	-	-	-	-	-	-	-	-	-	-
Thai	-	6	-	1	1	-	-	-	13	-
Other Asian	-	12	4	-	7	-	3	5	24	-
Bangladeshi	-	-	-	-	-	-	-	1	-	-
Burmese	-	-	-	-	-	-	-	-	-	-
Indonesian	-	1	-	-	-	-	-	-	-	-
Malayan	-	1	-	-	-	-	-	-	-	-
Okinawan	-	-	-	-	-	-	-	-	-	-
Pakistani	-	7	-	-	6	-	-	-	10	-
Sri Lankan	-	-	-	-	-	-	-	-	-	-
All other Asian	-	3	4	-	1	-	3	4	14	-
Pacific Islander	-	-	1	1	4	-	3	-	4	-
Hawaiian	-	-	1	1	3	-	2	-	-	-
Samoan	-	-	-	-	-	-	1	-	-	-
Guamanian	-	-	-	-	1	-	-	-	1	-
Other Pacific Islander	-	-	-	-	-	-	-	-	3	-
Tongan	-	-	-	-	-	-	-	-	-	-
Tahitian	-	-	-	-	-	-	-	-	-	-
Northern Mariana Islander	-	-	-	-	-	-	-	-	-	-
Palauan	-	-	-	-	-	-	-	-	-	-
Fijian	-	-	-	-	-	-	-	-	-	-
All other Pacific Islander	-	-	-	-	-	-	-	-	3	-
Other race	-	30	13	1	55	-	16	1	27	-
HISPANIC ORIGIN										
All persons	1 203	12 793	6 921	4 231	20 098	1 002	18 794	3 417	32 893	1 402
Hispanic origin (of any race)	1	115	33	33	185	-	86	25	278	1
Mexican	1	38	12	11	96	-	47	9	87	-
Puerto Rican	-	24	2	4	20	-	5	-	40	-
Cuban	-	11	-	9	10	-	5	7	31	-
Other Hispanic	-	42	19	9	57	-	29	9	120	1
Not of Hispanic origin	1 202	12 678	6 888	4 198	19 913	1 002	18 708	3 392	32 615	1 401
RACE AND HISPANIC ORIGIN										
All persons	1 203	12 793	6 921	4 231	20 098	1 002	18 794	3 417	32 893	1 402
White	1 201	12 242	5 037	4 133	16 289	989	15 107	3 363	31 299	1 391
Hispanic origin	1	88	15	29	115	-	66	23	242	1
Not of Hispanic origin	1 200	12 154	5 022	4 104	16 174	989	15 041	3 340	31 057	1 390
Black	-	181	1 838	38	3 615	2	3 594	2	610	9
Hispanic origin	-	3	5	2	14	-	4	-	6	-
Not of Hispanic origin	-	178	1 833	36	3 601	2	3 590	2	604	9
American Indian, Eskimo, or Aleut	2	18	7	2	36	1	26	13	63	1
Hispanic origin	-	-	-	1	-	-	1	-	-	-
Not of Hispanic origin	2	18	7	1	36	1	25	13	63	1
Asian or Pacific Islander	-	322	26	57	103	10	51	38	894	1
Hispanic origin	-	3	-	-	5	-	-	1	7	-
Not of Hispanic origin	-	319	26	57	98	10	51	37	887	1
Other race	-	30	13	1	55	-	16	1	27	-
Hispanic origin	-	21	13	1	51	-	15	1	23	-
Not of Hispanic origin	-	9	-	-	4	-	1	-	4	-
PERCENT DISTRIBUTION BY RACE										
All persons	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
White	99.8	95.7	72.8	97.7	81.0	98.7	80.4	98.4	95.2	99.2
Black	-	1.4	26.6	.9	18.0	.2	19.1	.1	1.9	.6
American Indian, Eskimo, or Aleut	.2	.1	.1	-	.2	.1	.1	.4	.2	.1
American Indian	.2	.1	.1	-	.2	.1	.1	.4	.1	.1
Asian or Pacific Islander	-	2.5	.4	1.3	.5	1.0	.3	1.1	2.7	.1
Asian	-	2.5	.4	1.3	.5	1.0	.3	1.1	2.7	.1
Pacific Islander	-	-	-	-	-	-	-	-	-	-
Other race	-	.2	.2	-	.3	-	.1	-	.1	-
PERCENT DISTRIBUTION BY HISPANIC ORIGIN										
All persons	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Hispanic origin (of any race)	.1	.9	.5	.8	.9	-	.5	.7	.8	.1
Mexican	.1	.3	.2	.3	.5	-	.3	.3	.3	-
Puerto Rican	-	.2	-	.1	.1	-	-	-	.1	-
Cuban	-	.1	-	.2	-	-	-	.2	.1	-
Other Hispanic	-	.3	.3	.2	.3	-	.2	.3	.4	.1
Not of Hispanic origin	99.9	99.1	99.5	99.2	99.1	100.0	99.5	99.3	99.2	99.9
PERCENT WHITE, NOT OF HISPANIC ORIGIN										
All persons	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
White	99.8	95.7	72.8	97.7	81.0	98.7	80.4	98.4	95.2	99.2
Not of Hispanic origin	99.8	95.0	72.6	97.0	80.5	98.7	80.0	97.7	94.4	99.1

Table 6. Race and Hispanic Origin: 1990—Con.

[For definitions of terms and meanings of symbols, see text]

Place and [In Selected States] County Subdivision [1,000 or More Persons]	Huntingdon town	Jacksboro town	Jackson city	Jamestown city	Jasper town	Jefferson City city	Jellico city	Johnson City city	Jonesborough town	Kams CDP
RACE										
All persons	4 180	1 568	48 949	1 862	2 780	5 494	2 447	49 381	3 091	1 458
White	3 391	1 559	28 943	1 857	2 539	5 090	2 359	45 971	2 890	1 445
Black	772	-	19 703	-	231	369	69	2 915	190	-
American Indian, Eskimo, or Aleut	8	-	39	2	1	11	19	98	5	5
American Indian	8	-	37	2	1	11	19	94	5	5
Eskimo	-	-	1	-	-	-	-	2	-	-
Aleut	-	-	1	-	-	-	-	2	-	-
Asian or Pacific Islander	3	6	213	2	6	13	-	321	4	4
Asian	3	6	210	2	6	11	-	318	4	4
Chinese	-	5	51	-	-	3	-	80	1	-
Filipino	-	-	26	-	-	-	-	17	2	1
Japanese	-	1	34	-	1	-	-	23	-	-
Asian Indian	3	-	48	2	2	4	-	110	-	1
Korean	-	-	13	-	1	1	-	32	-	2
Vietnamese	-	-	17	-	-	1	-	26	-	-
Cambodian	-	-	2	-	-	-	-	-	-	-
Hmong	-	-	-	-	-	-	-	-	-	-
Laotian	-	-	-	-	-	-	-	-	-	-
Thai	-	-	-	-	-	-	-	-	-	-
Other Asian	-	-	19	-	2	2	-	2	-	-
Bangladeshi	-	-	4	-	-	-	-	28	1	-
Burmese	-	-	-	-	-	1	-	-	-	-
Indonesian	-	-	1	-	-	-	-	-	-	-
Malaysian	-	-	3	-	-	-	-	1	-	-
Okinawan	-	-	-	-	2	-	-	3	-	-
Pakistani	-	-	-	-	-	-	-	-	-	-
Sri Lankan	-	-	-	-	-	-	-	9	-	-
All other Asian	-	-	11	-	-	1	-	-	-	-
Pacific Islander	-	-	3	-	-	2	-	15	1	-
Hawaiian	-	-	3	-	-	-	-	3	-	-
Samoan	-	-	-	-	-	2	-	2	-	-
Guamanian	-	-	-	-	-	2	-	1	-	-
Other Pacific Islander	-	-	-	-	-	-	-	-	-	-
Tongan	-	-	-	-	-	-	-	-	-	-
Tahitian	-	-	-	-	-	-	-	-	-	-
Northern Mariana Islander	-	-	-	-	-	-	-	-	-	-
Palauan	-	-	-	-	-	-	-	-	-	-
Fijian	-	-	-	-	-	-	-	-	-	-
All other Pacific Islander	-	-	-	-	-	-	-	-	-	-
Other race	6	3	51	1	3	11	-	76	2	4
HISPANIC ORIGIN										
All persons	4 180	1 568	48 949	1 862	2 780	5 494	2 447	49 381	3 091	1 458
Hispanic origin (of any race)	24	7	257	7	18	26	3	316	22	10
Mexican	11	4	85	-	2	10	3	116	11	4
Puerto Rican	2	-	28	1	-	4	-	40	2	-
Cuban	2	-	4	-	-	5	-	34	-	1
Other Hispanic	9	3	140	6	16	5	-	126	9	3
Not of Hispanic origin	4 156	1 561	48 692	1 855	2 762	5 470	2 444	49 065	3 069	1 448
RACE AND HISPANIC ORIGIN										
All persons	4 180	1 568	48 949	1 862	2 780	5 494	2 447	49 381	3 091	1 458
White	3 391	1 559	28 943	1 857	2 539	5 090	2 359	45 971	2 890	1 445
Hispanic origin	19	4	119	6	14	16	3	231	20	6
Not of Hispanic origin	3 372	1 555	28 824	1 851	2 525	5 074	2 356	45 740	2 870	1 439
Black	772	-	19 703	-	231	369	69	2 915	190	-
Hispanic origin	-	-	89	-	1	1	-	7	-	-
Not of Hispanic origin	772	-	19 614	-	230	368	69	2 908	190	-
American Indian, Eskimo, or Aleut	8	-	39	2	1	11	19	98	5	5
Hispanic origin	-	-	2	-	-	-	-	8	1	-
Not of Hispanic origin	8	-	37	2	1	11	19	90	4	5
Asian or Pacific Islander	3	6	213	2	6	13	-	321	4	4
Hispanic origin	-	-	7	-	-	-	-	5	-	-
Not of Hispanic origin	3	6	206	2	6	13	-	316	4	4
Other race	6	3	51	1	3	11	-	76	2	4
Hispanic origin	5	3	40	1	3	7	-	65	1	4
Not of Hispanic origin	1	-	11	-	-	4	-	11	1	-
PERCENT DISTRIBUTION BY RACE										
All persons	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
White	81.1	99.4	59.1	99.7	91.3	92.6	96.4	93.1	93.5	99.1
Black	18.5	-	40.3	-	8.3	6.7	2.8	5.9	6.1	-
American Indian, Eskimo, or Aleut	.2	-	.1	.1	-	.2	.8	.2	.2	.3
American Indian	.2	-	.1	.1	-	.2	.8	.2	.2	.3
Asian or Pacific Islander	.1	.4	.4	.1	.2	.2	-	.7	.1	.3
Asian	.1	.4	.4	.1	.2	.2	-	.6	.1	.3
Pacific Islander	-	-	-	-	-	-	-	-	-	-
Other race	.1	.2	.1	.1	.1	.2	-	.2	.1	.3
PERCENT DISTRIBUTION BY HISPANIC ORIGIN										
All persons	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Hispanic origin (of any race)	.6	.4	.5	.4	.6	.4	.1	.6	.7	.7
Mexican	.3	.3	.2	-	.1	.2	.1	.2	.4	.3
Puerto Rican	-	-	.1	.1	-	.1	-	.1	.1	-
Cuban	-	-	-	-	-	.1	-	.1	-	.1
Other Hispanic	.2	.2	.3	.3	.6	.1	-	.3	.3	.3
Not of Hispanic origin	99.4	99.6	99.5	99.6	99.4	99.6	99.9	99.4	99.3	99.3
PERCENT WHITE, NOT OF HISPANIC ORIGIN										
All persons	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
White	81.1	99.4	59.1	99.7	91.3	92.6	96.4	93.1	93.5	99.1
Not of Hispanic origin	80.7	99.2	58.9	99.4	90.8	92.4	96.3	92.6	92.9	98.7

Table 6. Race and Hispanic Origin: 1990—Con.

[For definitions of terms and meanings of symbols, see text]

Place and [In Selected States] County Subdivision [1,000 or More Persons]	Morristown city	Mosheim town	Mountain City town	Mount Carmel town	Mount Juliet city	Mount Pleasant city	Munford town	Murfreesboro city	Nashville-Davidson (remainder)	Newbern town
RACE										
All persons	21 385	1 451	2 169	4 082	5 389	4 278	2 326	44 922	488 374	2 515
White	19 324	1 447	2 130	4 056	5 199	3 141	2 135	36 977	360 284	2 076
Black	1 927	–	28	12	154	1 118	163	6 508	118 627	422
American Indian, Eskimo, or Aleut	39	1	4	6	12	5	7	82	1 130	5
American Indian	38	1	4	6	12	5	7	80	1 112	5
Eskimo	1	–	–	–	–	–	–	–	11	–
Aleut	–	–	–	–	–	–	–	2	7	–
Asian or Pacific Islander	66	3	3	8	13	12	17	1 253	6 852	9
Asian	61	3	3	8	13	8	17	1 245	6 754	8
Chinese	7	–	–	–	–	–	–	74	924	1
Filipino	5	–	1	3	3	–	9	24	419	–
Japanese	15	–	–	1	2	4	3	218	566	–
Asian Indian	5	–	–	–	4	4	–	173	1 149	–
Korean	7	–	2	4	4	–	4	31	872	3
Vietnamese	2	–	–	–	–	–	1	7	405	–
Cambodian	15	–	–	–	–	–	–	2	314	–
Hmong	–	–	–	–	–	–	–	–	11	–
Laotian	–	–	–	–	–	–	–	610	1 492	–
Thai	–	–	–	–	–	–	–	28	141	1
Other Asian	5	3	–	–	–	–	–	78	461	1
Bangladeshi	–	–	–	–	–	–	–	–	39	–
Burmese	–	–	–	–	–	–	–	–	4	–
Indonesian	–	–	–	–	–	–	–	2	42	–
Malayan	1	–	–	–	–	–	–	1	2	–
Okinawan	–	–	–	–	–	–	–	–	1	–
Pakistani	–	–	–	–	–	–	–	8	78	–
Sri Lankan	–	–	–	–	–	–	–	–	12	–
All other Asian	4	3	–	–	–	–	–	67	283	1
Pacific Islander	5	–	–	–	–	4	–	8	98	1
Hawaiian	–	–	–	–	–	4	–	7	65	–
Samoan	–	–	–	–	–	–	–	–	9	–
Guamanian	1	–	–	–	–	–	–	1	18	1
Other Pacific Islander	4	–	–	–	–	–	–	–	6	–
Tongan	–	–	–	–	–	–	–	–	–	–
Tahitian	–	–	–	–	–	–	–	–	–	–
Northern Mariana Islander	–	–	–	–	–	–	–	–	–	–
Palauan	–	–	–	–	–	–	–	–	–	–
Fijian	–	–	–	–	–	–	–	–	1	–
All other Pacific Islander	4	–	–	–	–	–	–	–	5	–
Other race	29	–	4	–	11	2	4	102	1 481	3
HISPANIC ORIGIN										
All persons	21 385	1 451	2 169	4 082	5 389	4 278	2 326	44 922	488 374	2 515
Hispanic origin (of any race)	91	–	9	8	44	13	15	358	4 632	11
Mexican	36	–	7	3	18	9	10	90	2 093	7
Puerto Rican	16	–	–	–	7	–	1	46	510	1
Cuban	7	–	1	–	1	–	–	19	333	–
Other Hispanic	32	–	1	5	18	4	4	201	1 696	3
Not of Hispanic origin	21 294	1 451	2 160	4 074	5 345	4 265	2 311	44 564	483 742	2 504
RACE AND HISPANIC ORIGIN										
All persons	21 385	1 451	2 169	4 082	5 389	4 278	2 326	44 922	488 374	2 515
White	19 324	1 447	2 130	4 056	5 199	3 141	2 135	36 977	360 284	2 076
Hispanic origin	55	–	5	8	24	11	11	197	2 778	7
Not of Hispanic origin	19 269	1 447	2 125	4 048	5 165	3 130	2 124	36 780	357 506	2 069
Black	1 927	–	28	12	154	1 118	163	6 508	118 627	422
Hispanic origin	8	–	–	–	–	1	–	32	452	1
Not of Hispanic origin	1 919	–	28	12	154	1 117	163	6 476	118 174	421
American Indian, Eskimo, or Aleut	39	1	4	6	12	5	7	82	1 130	5
Hispanic origin	2	–	–	–	–	–	–	5	69	–
Not of Hispanic origin	37	1	4	6	12	5	7	77	1 061	5
Asian or Pacific Islander	66	3	3	8	13	12	17	1 253	6 852	9
Hispanic origin	1	–	–	–	–	–	–	53	154	–
Not of Hispanic origin	65	3	3	8	13	12	17	1 200	6 698	9
Other race	29	–	4	–	11	2	4	102	1 481	3
Hispanic origin	25	–	4	–	10	1	4	71	1 228	3
Not of Hispanic origin	4	–	–	–	1	1	–	31	253	–
PERCENT DISTRIBUTION BY RACE										
All persons	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
White	90.4	99.7	98.2	99.4	96.5	73.4	91.8	82.3	73.8	82.5
Black	9.0	–	1.3	.3	2.9	26.1	7.0	14.5	24.3	16.8
American Indian, Eskimo, or Aleut	.2	.1	.2	.1	.2	.1	.3	.2	.2	.2
American Indian	.2	.1	.2	.1	.2	.1	.3	.2	.2	.2
Asian or Pacific Islander	.3	.2	.1	.2	.2	.3	.7	2.8	1.4	.4
Asian	.3	.2	.1	.2	.2	.2	.7	2.8	1.4	.3
Pacific Islander	–	–	–	–	–	.1	–	–	–	–
Other race	.1	–	.2	–	.2	–	.2	.2	.3	.1
PERCENT DISTRIBUTION BY HISPANIC ORIGIN										
All persons	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Hispanic origin (of any race)	.4	–	.4	.2	.8	.3	.6	.8	.9	.4
Mexican	.2	–	.3	.1	.3	.2	.4	.2	.4	.3
Puerto Rican	.1	–	–	–	.1	–	–	.1	.1	–
Cuban	–	–	–	–	–	–	–	–	.1	–
Other Hispanic	.1	–	–	.1	.3	.1	.2	.4	.3	.1
Not of Hispanic origin	99.6	100.0	99.6	99.8	99.2	99.7	99.4	99.2	99.1	99.6
PERCENT WHITE, NOT OF HISPANIC ORIGIN										
All persons	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
White	90.4	99.7	98.2	99.4	96.5	73.4	91.8	82.3	73.8	82.5
Not of Hispanic origin	90.1	99.7	98.0	99.2	95.8	73.2	91.3	81.9	73.2	82.3

Table 6. Race and Hispanic Origin: 1990—Con.

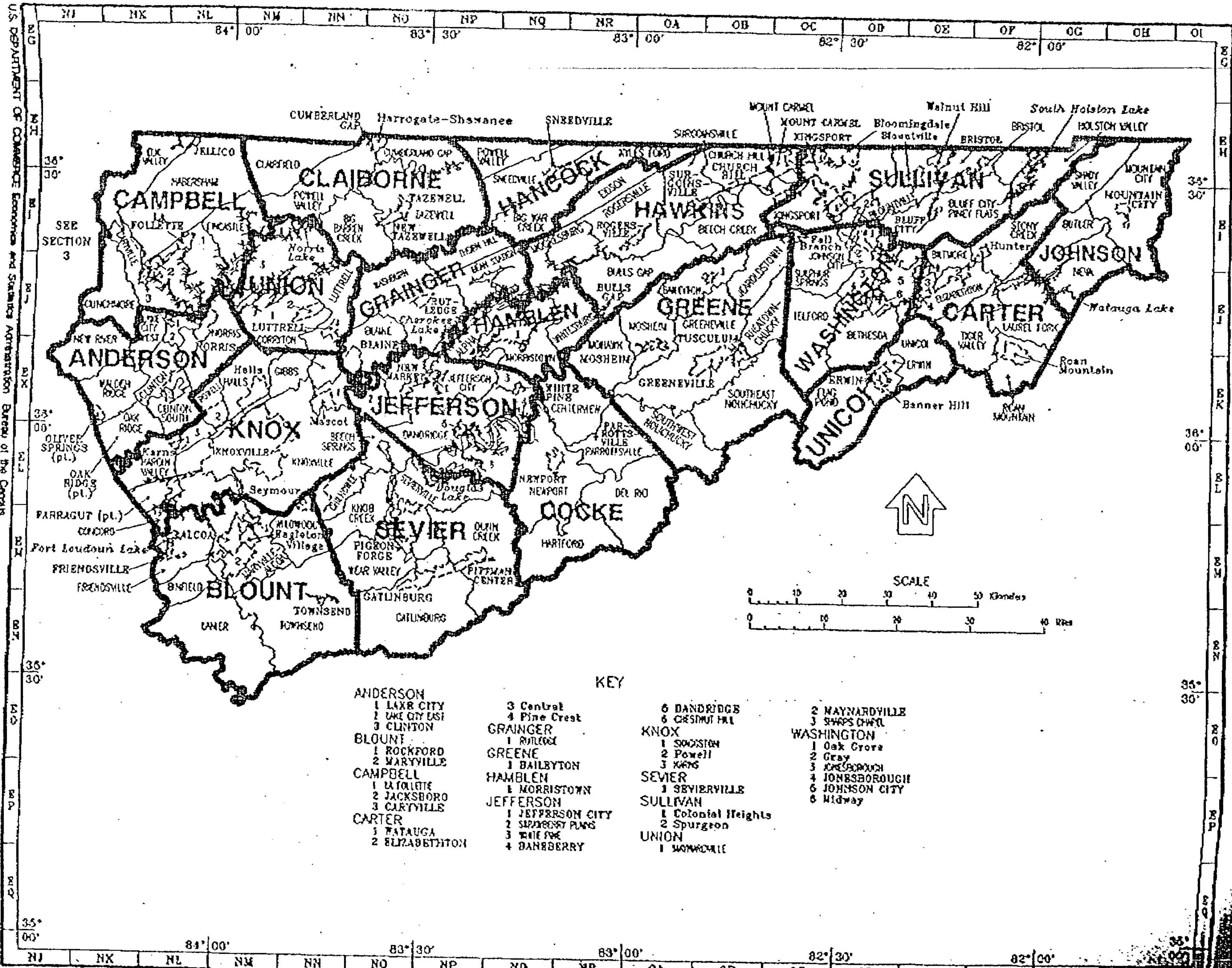
[For definitions of terms and meanings of symbols, see text]

Place and [In Selected States] County Subdivision [1,000 or More Persons]	Walnut Hill CDP	Walnut Hill COP	Watertown city	Waverly city	Waynesboro city	Westmoreland town	White Bluff town	White House city
RACE								
All persons	3 332	1 043	1 250	3 925	1 824	1 726	1 988	2 987
White	3 300	924	1 169	3 446	1 799	1 724	1 983	2 919
Black	17	117	81	448	24	1	–	55
American Indian, Eskimo, or Aleut	6	–	–	7	1	–	3	10
American Indian	6	–	–	7	1	–	3	10
Eskimo	–	–	–	–	–	–	–	–
Aleut	–	–	–	–	–	–	–	–
Asian or Pacific Islander	9	2	–	18	–	1	2	2
Asian	9	–	–	15	–	1	2	2
Chinese	2	–	–	5	–	–	–	–
Filipino	–	–	–	–	–	–	–	1
Japanese	1	–	–	1	–	–	2	–
Asian Indian	–	–	–	9	–	–	–	–
Korean	1	–	–	–	–	–	–	1
Vietnamese	4	–	–	–	–	–	–	–
Cambodian	–	–	–	–	–	–	–	–
Hmong	–	–	–	–	–	–	–	–
Laotian	–	–	–	–	–	–	–	–
Thai	–	–	–	–	–	–	–	–
Other Asian	1	–	–	–	–	1	–	–
Bangladeshi	–	–	–	–	–	–	–	–
Burmese	–	–	–	–	–	–	–	–
Indonesian	–	–	–	–	–	–	–	–
Malayan	1	–	–	–	–	–	–	–
Okinawan	–	–	–	–	–	–	–	–
Pakistani	–	–	–	–	–	–	–	–
Sri Lankan	–	–	–	–	–	–	–	–
All other Asian	–	–	–	–	–	1	–	–
Pacific Islander	–	2	–	3	–	–	–	–
Hawaiian	–	1	–	–	–	–	–	–
Samoan	–	–	–	–	–	–	–	–
Guamanian	–	1	–	2	–	–	–	–
Other Pacific Islander	–	–	–	1	–	–	–	–
Tongan	–	–	–	–	–	–	–	–
Tahitian	–	–	–	–	–	–	–	–
Northern Mariana Islander	–	–	–	–	–	–	–	–
Palauan	–	–	–	–	–	–	–	–
Fijian	–	–	–	–	–	–	–	–
All other Pacific Islander	–	–	–	1	–	–	–	–
Other race	–	–	–	6	–	–	–	1
HISPANIC ORIGIN								
All persons	3 332	1 043	1 250	3 925	1 824	1 726	1 988	2 987
Hispanic origin (of any race)	6	4	3	29	1	–	4	14
Mexican	4	4	1	15	1	–	3	4
Puerto Rican	–	–	–	–	–	–	–	6
Cuban	2	–	1	6	–	–	–	–
Other Hispanic	–	–	1	8	–	–	1	4
Not of Hispanic origin	3 326	1 039	1 247	3 896	1 823	1 726	1 984	2 973
RACE AND HISPANIC ORIGIN								
All persons	3 332	1 043	1 250	3 925	1 824	1 726	1 988	2 987
White	3 300	924	1 169	3 446	1 799	1 724	1 983	2 919
Hispanic origin	6	4	2	22	1	–	4	13
Not of Hispanic origin	3 294	920	1 167	3 424	1 798	1 724	1 979	2 906
Black	17	117	81	448	24	1	–	55
Hispanic origin	–	–	1	1	–	–	–	–
Not of Hispanic origin	17	117	80	447	24	1	–	55
American Indian, Eskimo, or Aleut	6	–	–	7	1	–	3	10
Hispanic origin	–	–	–	–	–	–	–	–
Not of Hispanic origin	6	–	–	7	1	–	3	10
Asian or Pacific Islander	9	2	–	18	–	1	2	2
Hispanic origin	–	–	–	–	–	–	–	–
Not of Hispanic origin	9	2	–	18	–	1	2	2
Other race	–	–	–	6	–	–	–	1
Hispanic origin	–	–	–	6	–	–	–	1
Not of Hispanic origin	–	–	–	–	–	–	–	–
PERCENT DISTRIBUTION BY RACE								
All persons	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
White	99.0	88.6	93.5	87.8	98.6	99.9	99.7	97.7
Black	.5	11.2	6.5	11.4	1.3	.1	–	1.8
American Indian, Eskimo, or Aleut	.2	–	–	.2	.1	–	.2	.3
American Indian	.2	–	–	.2	.1	–	.2	.3
Asian or Pacific Islander	.3	.2	–	.5	–	.1	.1	.1
Asian	.3	–	–	.4	–	.1	.1	.1
Pacific Islander	–	.2	–	.1	–	–	–	–
Other race	–	–	–	.2	–	–	–	–
PERCENT DISTRIBUTION BY HISPANIC ORIGIN								
All persons	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Hispanic origin (of any race)	.2	.4	.2	.7	.1	–	.2	.5
Mexican	.1	.4	.1	.4	.1	–	.2	.1
Puerto Rican	–	–	–	–	–	–	–	.2
Cuban	.1	–	.1	.2	–	–	–	–
Other Hispanic	–	–	.1	.2	–	–	.1	.1
Not of Hispanic origin	99.8	99.6	99.8	99.3	99.9	100.0	99.8	99.5
PERCENT WHITE, NOT OF HISPANIC ORIGIN								
All persons	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
White	99.0	88.6	93.5	87.8	98.6	99.9	99.7	97.7
Not of Hispanic origin	98.9	88.2	93.4	87.2	98.6	99.9	99.5	97.3

ATTACHMENT

Question 4

Counties, County Subdivisions, and Places - Section 4



KEY

ANDERSON
1 LAKE CITY
2 LAKE CITY EAST
3 CLINTON

BLOUNT
1 ROCKFORD
2 MARYVILLE

CAMPBELL
1 LA FOLLETTE
2 JACKSBORO
3 CARYVILLE

CARTER
1 WATAUGA
2 ELIZABETHTON
3 Central
4 Pine Crest

GRAINGER
1 RUTLEDGE

GREENE
1 BAILEYTON

HAMBLEN
1 MORRISTOWN

JEFFERSON
1 JEFFERSON CITY
2 STRAWBERRY PLAINS
3 WHITE PINE
4 DANSBERRY
5 DANDRIDGE
6 CHESTNUT HILL

KNOX
1 SKAGGSTON
2 Powell
3 KARNS

SEVIER
1 SEVIERVILLE

SULLIVAN
1 Colonial Heights
2 Spurgeon

UNION
1 MAYNARDVILLE
2 MAYNARDVILLE
3 SHARPS CHAPEL

WASHINGTON
1 Oak Grove
2 Gray
3 JONESBOROUGH
4 JONESBOROUGH
5 JOHNSON CITY
6 Midway

U.S. DEPARTMENT OF COMMERCE Economics and Statistics Administration Bureau of the Census
MAPS

ATTACHMENT

Question 5

Tennessee Valley Authority
Division of Water Management
Water Systems Development Branch

EFFECT OF WATTS BAR NUCLEAR PLANT AND WATTS BAR STEAM PLANT DISCHARGES ON CHICKAMAUGA LAKE WATER TEMPERATURES

WM28-1-85-100

Prepared by
Christopher D. Ungate
and
Kenneth A. Howerton
Norris, Tennessee
February 1977

INTRODUCTION

The Tennessee Valley Authority is constructing a two-unit 2540 megawatts (mw) nuclear generating plant in Rhea County, Tennessee, on the right bank of Chickamauga Lake adjacent to the Watts Bar Dam Reservation near Tennessee River Mile (TRM) 528 (Figure 1). This plant is situated approximately two miles downstream of Watts Bar Dam at TRM 529.9 and approximately one mile downstream of the four-unit 240 mw coal-fired Watts Bar Steam Plant on the right bank of Chickamauga Lake at TRM 529. This report discusses the individual and combined near-field effects of the nuclear and steam plant discharges on Chickamauga Lake water temperatures.

Previous reports have described the design of the multiport diffuser system for the nuclear plant (Reference 1) and the results of hydrothermal model tests of the diffuser (Reference 2). Summaries of river and wet bulb temperatures applicable to the plant site are presented and used to analyze the projected operation of the closed cycle heat dissipation and blowdown discharge systems of the plant. Revised operating properties of the diffuser system are also given using revised estimates of the maximum discharge rate from the plant (Reference 3).

The results of water temperature surveys have been used to study the mixing of the surface discharge from the once-through cooling system of the steam plant (Reference 4). Surface jet models and additional water temperature surveys are used to further characterize the effects of the steam plant discharge.

The combined effect of the steam and nuclear plant discharges is studied for periods of steady river flows and for periods during and

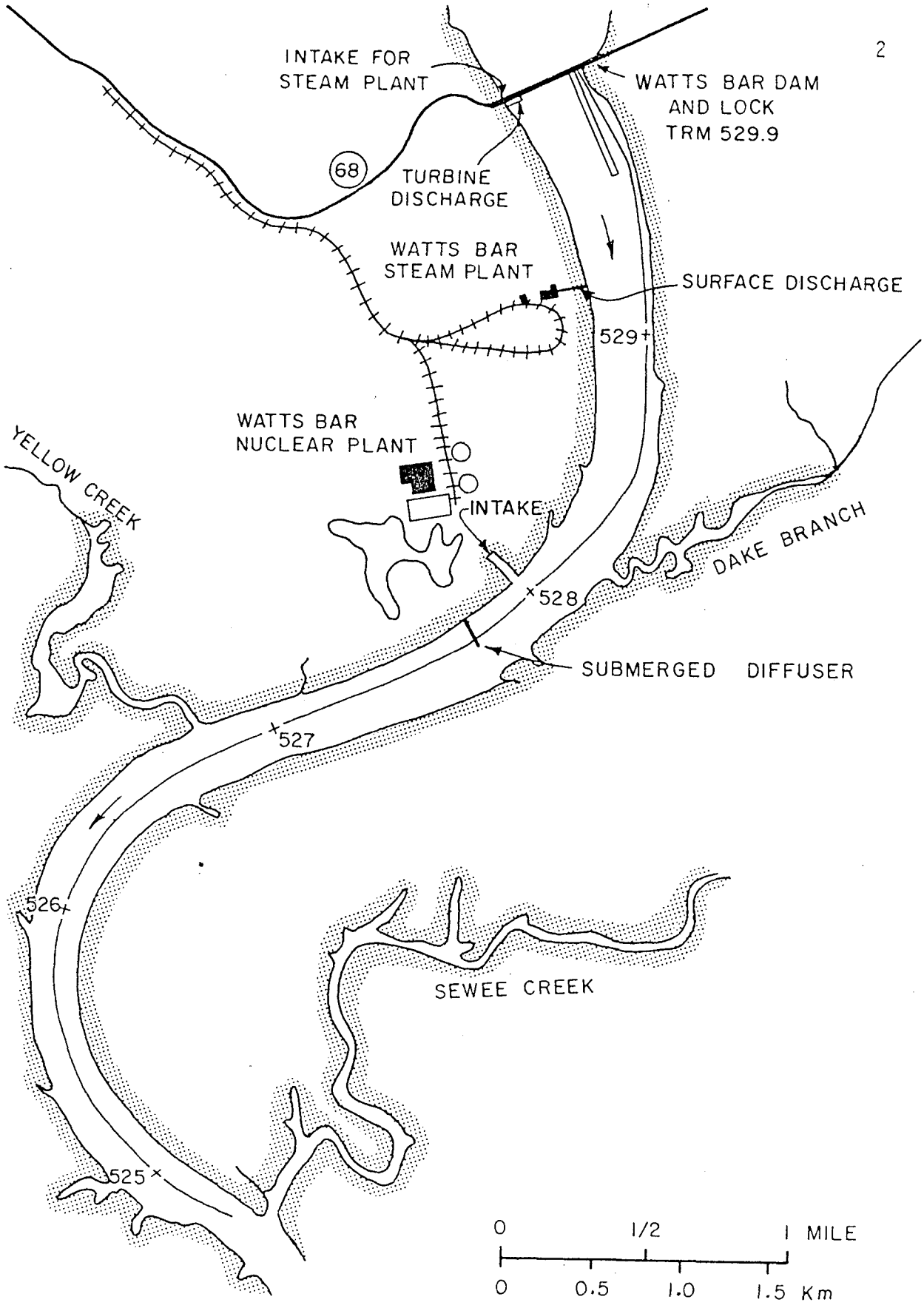


Figure 1: Tennessee River Near Watts Bar Dam

immediately following times of no release from Watts Bar Dam. Advection and diffusion models are utilized to determine the near field effects of the plant discharges. Compliance with the water temperature standards of the State of Tennessee is analyzed.

WATTS BAR DAM DISCHARGES

Watts Bar Dam discharge records, maintained since its closure on January 1, 1942, indicate that the average discharge at the dam has been 26,480 cubic feet per second (cfs). Flow data for water years 1951-1965 indicate an average flow of about 21,500 cfs during the summer months and about 35,500 cfs during the winter months. Watts Bar Dam is operated to provide peaking power as indicated in Figure 2, which shows no discharge from the dam 10.5 percent of the hours during the year. The maximum duration of no discharge periods is 12 hours, except for planned special operations. The normal discharge through each of the five turbines at the dam ranges from 7,500 to 10,000 cfs. The minimum flow at which the turbines can operate is 3,500 cfs, although discharges seldom fall below about 5,000 cfs per unit.

Water surface elevations downstream of Watts Bar Dam in the vicinity of the plant sites are determined by the headwater elevation at Chickamauga Dam and the discharge from Watts Bar Dam. Chickamauga Lake elevations vary from a normal maximum elevation of 683.0 feet in the summer months to a normal minimum elevation of 675.0 feet in the winter months. However, Watts Bar Dam discharges may raise the water surface elevation if the lake elevation is less than 683.0 feet. Table 1 shows the approximate stage-discharge relationship below Watts Bar Dam at minimum pool conditions in the winter.

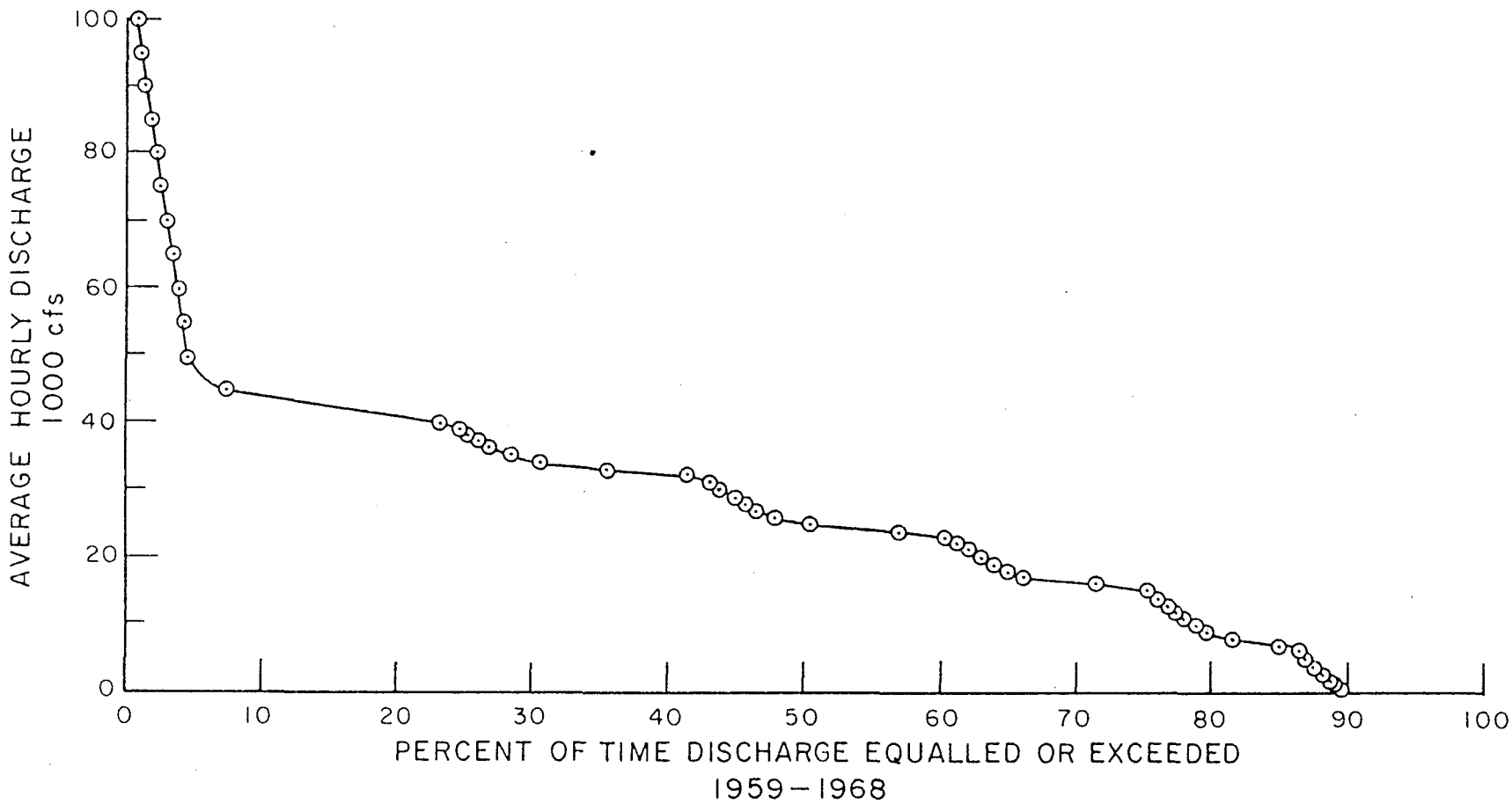


Figure 2 : Flow Frequency at Watts Bar Dam

Table 1

Approximate Stage Discharge Relationship

Immediately Below Watts Bar Dam

Chickamauga Lake Elevation 675.0 feet

Water Surface Elevation (feet)	Watts Bar Dam Discharge (cfs)
675	0
677	12,500
679	25,000
681	37,500
683	50,000
696	190,000

WATTS BAR NUCLEAR PLANT DISCHARGE CHARACTERISTICS

Intake and Discharge Design

A closed-cycle heat dissipation system consisting of two natural draft cooling towers is utilized for the Watts Bar Nuclear Plant. Makeup water for the plant is supplied via an intake channel and pumping station at TRM 528.0. The average and maximum intake flow rates are 133 cfs and 143 cfs, respectively, at a concentration factor of two.

A physical description of the diffuser discharge system is given in Table 2 and depicted in Figure 3. The diffuser system consists of two pipes branching from a central conduit at the right bank of Chickamauga Lake and extending in a direction perpendicular to the river flow into the Tennessee River. Each pipe is controlled by a 54-inch diameter butterfly valve located a short distance from the wye with the central conduit.

The downstream leg consists of approximately 297 feet of 4.5-foot diameter paved corrugated steel approach pipe connected to 160 feet of unpaved 1- x 3-inch corrugated steel diffuser pipe of the same diameter. The diffuser pipe section is half buried in the river bottom and contains two 1-inch diameter ports per corrugation. The centroid of the ports is oriented at an angle of 45° from the horizontal in a downstream direction.

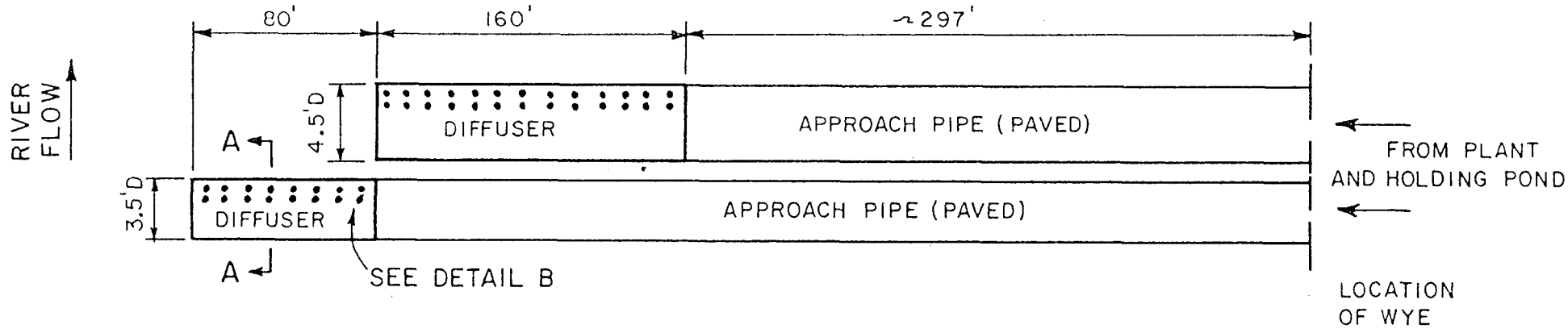
The upstream leg consists of approximately 447 feet of 3.5-foot diameter paved corrugated steel approach pipe connected to 80 feet of unpaved 1- x 3-inch corrugated steel diffuser pipe of the same diameter. The upstream diffuser pipe section is also half buried in the

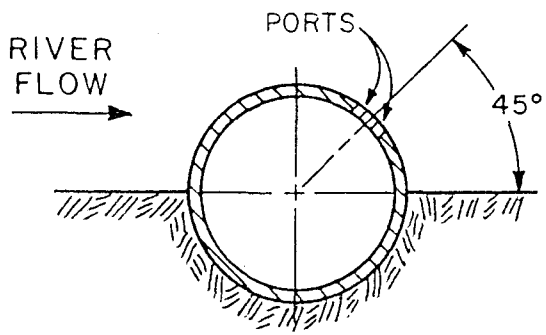
Table 2

Dimensions of Recommended Diffusers

Watts Bar Nuclear Plant

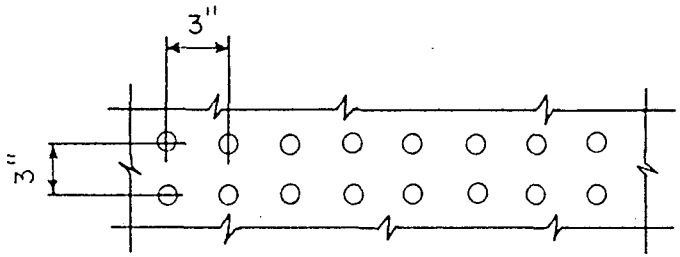
	Upstream Leg	Downstream Leg	Total
Diffuser			
Pipe Length (ft) (unpaved 1- x 3-inch corrugated steel pipe)	80.0	160.0	240.0
Pipe Diameter (ft)	3.5	4.5	
Port Diameter (in)	1.0	1.0	
Number of Ports Per Corrugation	2	2	
Port Spacing Normal to Corrugation (in)	3.0	3.0	
Port Spacing Parallel to Corrugation (in)	3.0	3.0	
Friction Factor	0.0948	0.0841	
Approach Pipe			
Pipe Length (ft) (paved corrugated) steel pipe)	447.0	297.0	474.0
Pipe Diameter (ft)	3.5	4.5	
Friction Factor	0.0191	0.0148	





SECTION A-A

1"X3" CORRUGATED STEEL PIPE-UNPAVED



DETAIL B

ARRANGEMENT OF PORTS
PORT DIAMETER 1"
PORT SPACING
3" HORIZONTAL, 3" VERTICAL

Figure 3: Description of Multiport Diffuser System
Watts Bar Nuclear Plant

river bottom and extends its entire length of 80 feet beyond the dead end of the downstream diffuser pipe section. The port diameter, spacing and orientation of the upstream leg is the same as that of the downstream leg.

The location of the diffuser system at TRM 527.8 is shown in Figure 4. Both the upstream and downstream legs are located beneath the navigation channel, as indicated by buoy markers on Figure 4. The location of the diffuser was chosen so that the depth of water above the diffuser will be sufficient to allow for the safe passage of barges.

Discharge Rates

Blowdown will be discharged at a rate of between 44.6 and 85.0 cfs from the cooling tower basins so as to maintain the concentration of dissolved solids in the cooling towers at approximately twice that found in the Tennessee River (Reference 3). Blowdown will be discharged into a holding pond of approximately 190 acre-feet capacity during periods of no releases from Watts Bar Dam to avoid exceeding applicable thermal standards. When sufficient water is released from Watts Bar Dam (at least 3500 cfs), blowdown may again be discharged to the river. Blowdown from the holding pond can be discharged to the river at a rate of 60.2 to 85.0 cfs.

Modes of Operation

A mode of operation for the diffuser system is defined as any one of the possible combinations of diffuser pipe sections which may discharge blowdown under particular circumstances. Thus, for the

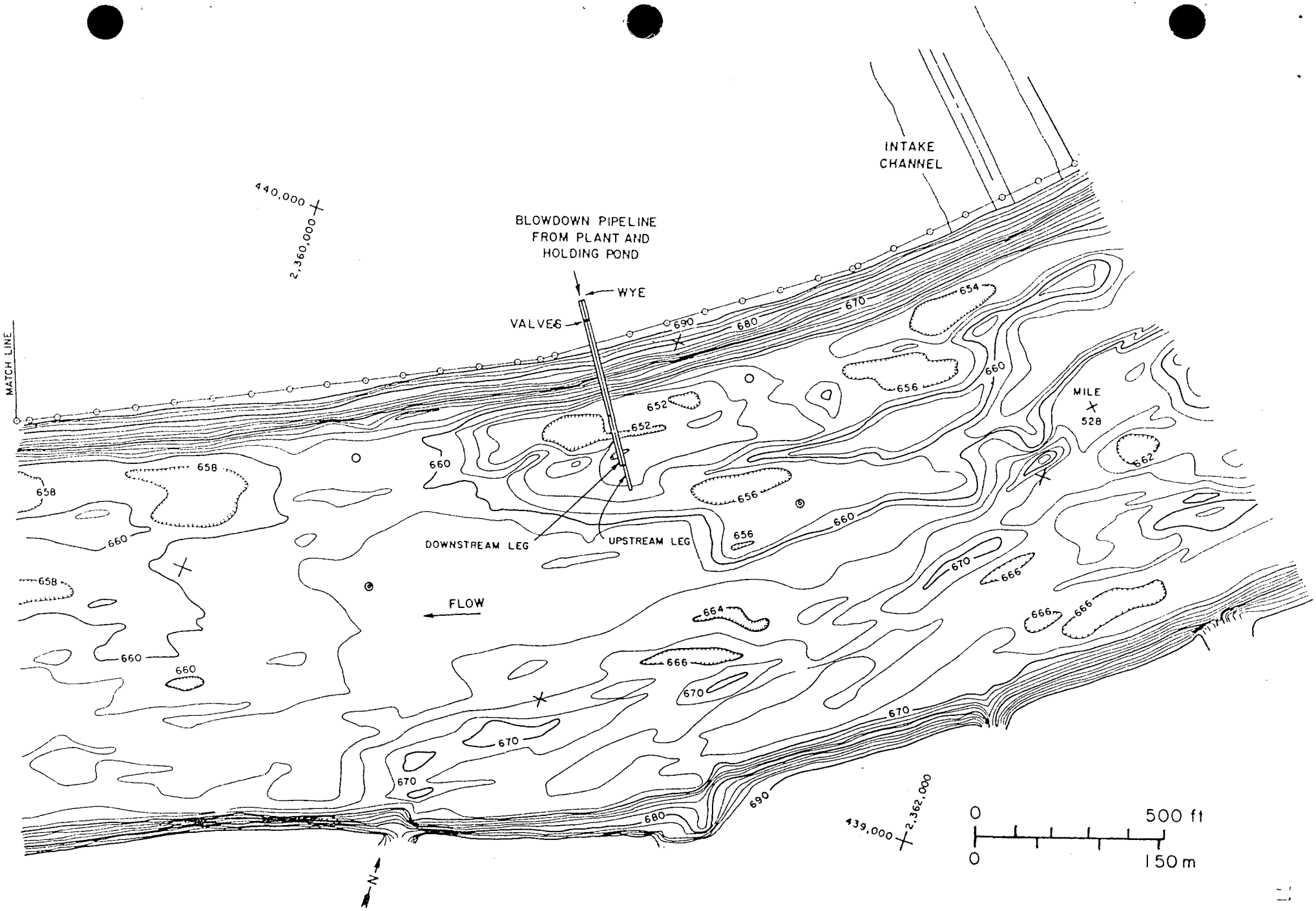


Figure 4 – Location of Multiport Diffuser System
Watts Bar Nuclear Plant

Watts Bar Nuclear Plant diffuser system, the first mode consists of only the upstream leg discharging blowdown; the second mode consists of only the downstream leg discharging blowdown; and the third mode consists of both the upstream and downstream legs discharging blowdown. Mode 1 is used when either unit 1 or unit 2 is operated alone and there is no holding pond discharge. Mode 2 is used when both units are operated simultaneously and there is no holding pond discharge or when stored blowdown is discharged from the holding pond and there is no discharge from the cooling tower basins. Mode 3 is used when either or both of the units are operated at the same time as stored blowdown is discharged from the holding pond. Table 3 summarizes the minimum and maximum blowdown flow rates that can be expected for each mode.

Operational Characteristics

The operational characteristics for the minimum and maximum flows of each mode are summarized in Table 4. The average jet exit velocity, approach pipe velocity and the required head at three locations in the pipe are presented. Table 4 shows that the average jet exit velocity varies from 6.8 to 17.3 feet per second (fps) for all the operational modes, which provides ample mixing.

Discharge Temperature

The discharge temperature will depend primarily on the blowdown temperature from the natural draft cooling towers. Heat losses will occur when blowdown is stored in the holding pond, but these losses are conservatively assumed to be zero for this analysis.

Table 3

Summary of Modes of Operation

Blowdown Diffuser System

Watts Bar Nuclear Plant

	Mode of Operation	Diffuser System Flow Rate		Distribution of Flow			
				Minimum		Maximum	
		Minimum (cfs)	Maximum (cfs)	Upstream Leg (cfs)	Downstream Leg (cfs)	Upstream Leg (cfs)	Downstream Leg (cfs)
1	One unit only	22.3	50.0	22.3	----	50.0	----
2	Two units only or Holding pond discharge only	44.6	85.0	----	44.6	----	85.0
3	Either or both units + Holding pond discharge	82.5	170.0	27.5	55.0	56.7	113.3

Blowdown rate for one unit: 22.3 - 50.0 cfs
Blowdown rate for two units: 44.6 - 85.0 cfs
Holding pond discharge rate: 60.2 - 85.0 cfs

Table 4

Operating Properties of Blowdown Diffusers

Watts Bar Nuclear Plant

	Individual Operation of Diffuser Legs				Combined Operation of Diffuser Legs			
	Mode 1		Mode 2		Mode 3			
	Upstream Leg		Downstream Leg		Minimum		Maximum	
	Minimum	Maximum	Minimum	Maximum	Upstream	Downstream	Upstream	Downstream
Blowdown Rate (cfs)	22.3	50.0	44.6	85.0	27.5	55.0	56.7	113.3
Port Velocity (fps)	6.8	15.3	6.8	13.0	8.4	8.4	17.3	17.3
Approach Pipe Velocity (fps)	2.3	5.2	2.8	5.3	2.9	3.5	5.9	7.1
Dead End Head (ft)	1.6	8.1	1.6	5.8	2.4	2.4	10.4	10.4
Diffuser Head Req'd (ft)	1.7	8.4	1.7	6.3	2.5	2.6	10.8	11.1
Total Head Req'd (ft) from Wye	1.9	9.4	1.8	6.7	2.8	2.8	12.1	11.9

Blowdown Temperature

The performance characteristics of the natural draft cooling towers at the site depend primarily on the wet bulb temperature. A summary of wet bulb temperatures applicable to Watts Bar based on 11 years of record at Chattanooga, Tennessee, is given in Table 5 (Reference 5). The estimated blowdown temperature from the natural draft cooling towers is shown as a function of the wet bulb temperature on Figure 5. The relationship between blowdown and wet bulb temperatures is given as a polynomial curve fit of monthly average blowdown temperature computed as a function of monthly average meteorological data. The performance curve for natural draft cooling towers has been provided by Research Cottrell, Inc. (Reference 6). The predicted yearly cycle of blowdown temperatures for natural draft cooling towers, based on these wet bulb temperatures and estimated performance characteristics, is given in Table 6. Average blowdown temperatures range from 63°F in January to 85°F in July. The maximum blowdown temperature is 95°F.

River Temperature

A summary of tailrace temperatures at Watts Bar Dam is given in Table 7. These temperatures are representative of water temperatures at the plant site and will be used to compute expected initial temperature differences between the blowdown and the river before mixing. Table 7 shows that monthly average river temperatures vary from 43.5°F in January to 76.5°F in August. The maximum weekly observed tailrace temperature was 86.0°F in July and August, and the minimum weekly tailrace temperature was 32.0°F in January.

Table 5

Summary of Wet Bulb Temperatures

National Weather Service

Chattanooga, Tennessee

1963 - 1973

Month	Trihourly Maximum (°F)	Monthly Average +σ (°F)	Monthly Average (°F)	Monthly Average -σ (°F)	Trihourly Minimum (°F)
January	65	45.6	33.6	21.6	- 9
February	64	43.7	33.9	24.1	2
March	70	54.5	44.1	33.7	15
April	74	62.5	53.5	44.5	27
May	77	67.8	60.5	53.2	33
June	80	73.2	67.9	62.6	42
July	82	74.8	70.5	66.2	52
August	83	75.3	70.5	65.7	53
September	79	71.9	65.4	58.9	34
October	75	63.2	54.1	45.0	27
November	71	55.6	44.8	34.0	11
December	68	48.9	37.6	26.3	9

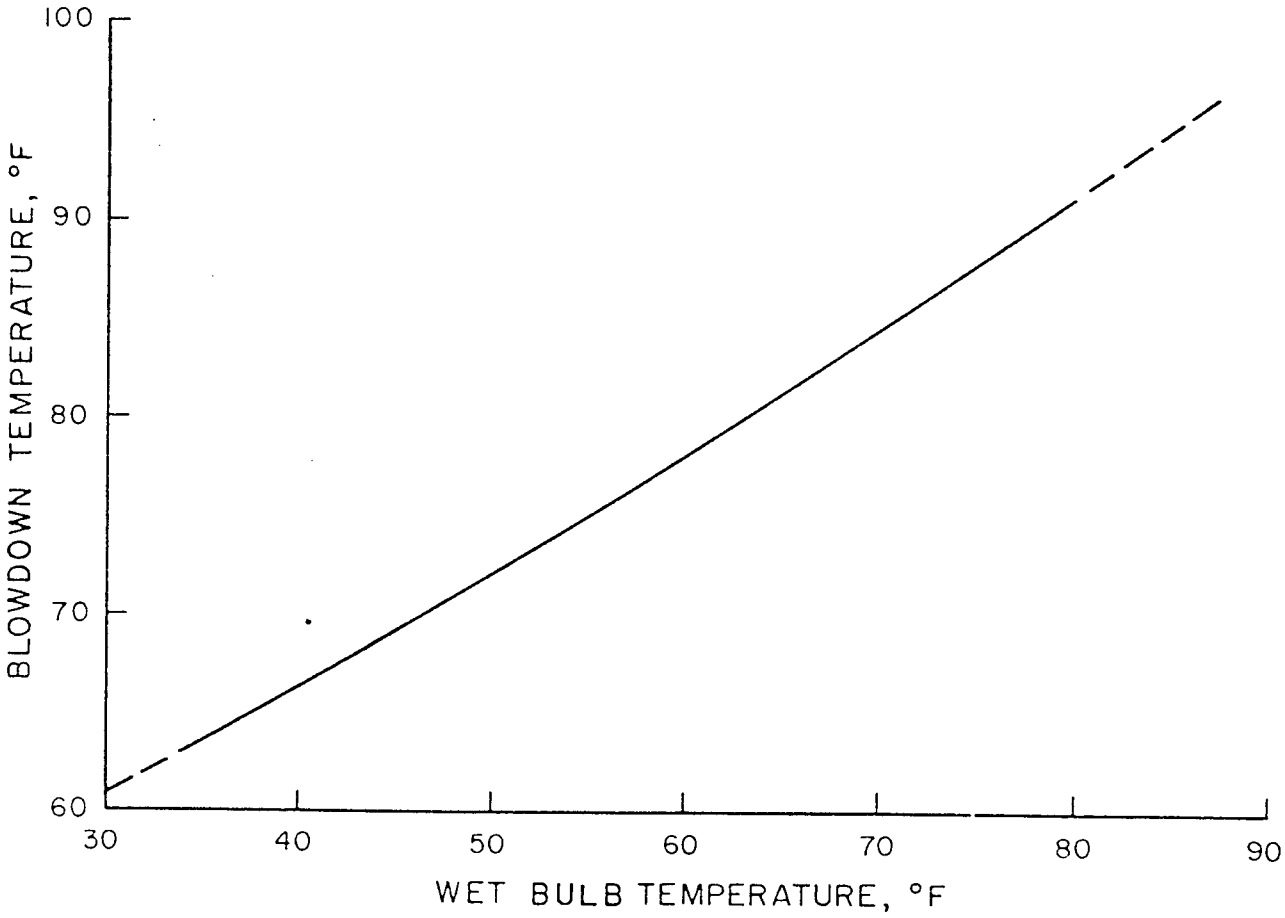


Figure 5 : Cooling Tower Performance Curve
Watts Bar Nuclear Plant

Table 6

Summary of Blowdown Temperatures

Watts Bar Nuclear Plant

Month	Monthly Average +σ (°F)	Monthly Average (°F)	Monthly Average -σ (°F)
January	69	63	(57)[1]
February	68	64	(59)
March	74	68	63
April	79	74	69
May	83	78	74
June	86	82	79
July	87	85	82
August	88	84	81
September	85	81	77
October	80	74	69
November	75	68	63
December	71	66	(60)

1. Parentheses indicate blowdown temperatures based upon extrapolated cooling tower performance curves.

Table 7

Summary of Tailrace Temperatures

Watts Bar Dam

February 1950 - September 1977

Month	Minimum (°F)	Average (°F)	Maximum (°F)
January	32.0	43.5	51.8
February	36.5	43.9	62.6
March	37.4	48.9	62.6
April	47.8	56.8	65.3
May	48.2	66.0	76.1
June	64.4	72.7	84.2
July	67.1	76.1	86.0
August	69.8	76.5	86.0
September	64.4	75.6	81.5
October	48.2	68.5	77.0
November	41.9	57.9	71.6
December	37.4	48.7	59.0
AVERAGE		60.5	

n.b. Based upon 1320 weekly observations, varying in number from 40 to 67 in any full year of record. Data missing for 1956, January-June 1957 and February 1969.

A summary of the probability of high tailrace temperatures is given in Table 8, showing river temperatures approaching the State of Tennessee maximum water temperature standard of 86.9°F (30.5°C).

Temperature Difference Between Blowdown and River Before Mixing

Table 9 shows the temperature difference between the blowdown and the river before mixing. Although the difference between the maximum possible blowdown temperature and the minimum observed river temperature is the greatest positive temperature difference, the conditions necessary to produce the maximum blowdown temperature and the minimum weekly river temperature are highly unlikely to occur simultaneously. The maximum blowdown temperature will most likely occur when the wet bulb temperature is the highest and the minimum river temperature will occur when the wet bulb temperature is the lowest. For the purpose of evaluating discharge system effects, it is more realistic to use the temperature difference between the average tri-hourly blowdown temperature plus one standard deviation for each month and the minimum weekly river temperature for each month for design conditions. Table 9 shows that the expected differences between blowdown and river temperatures before mixing vary from -9°F in November to 37°F in January and March.

Table 8

Probability of High Tailrace Temperatures

Watts Bar Dam

February 1950 - September 1977

T_i (°C)	T_i (°F)	Percentage of Weekly Observations Exceeding T_i (percent/year)	Average No. of Weekly Observations Exceeding T_i (No./year)
23.5	74.3	23.1	12.0
24.5	76.1	15.8	8.2
25.5	77.9	7.3	3.8
26.5	79.7	3.1	1.6
27.5	81.5	0.7	0.4
28.5	83.3	0.5	0.2
29.5	85.1	0.3	0.2
30.5	86.9	0.0	0.00

n.b. Based upon 1320 weekly observations, varying in number from 40 to 67 in any full year of record. Data missing for 1956, January-June 1957 and February 1969.

Table 9

Expected Differences Between
Blowdown and River Temperatures
Before Mixing
Watts Bar Nuclear Plant

Month	$T_{B_{-\sigma}} - T_{R_{max}}$ (°F)	$T_{B_{avg}} - T_{R_{avg}}$ (°F)	$T_{B_{+\sigma}} - T_{R_{min}}$ (°F)
January	(5)[1]	19	37
February	(4)	20	32
March	0	19	37
April	4	17	31
May	-2	12	35
June	-5	9	22
July	-4	9	11
August	-5	7	18
September	-5	5	21
October	-8	6	32
November	-9	10	33
December	(1)	17	34
AVERAGE		13	

1. Parentheses indicate temperature differences computed using blowdown temperatures based upon extrapolated cooling tower performance curves.

WATTS BAR STEAM PLANT DISCHARGE CHARACTERISTICS

Intake and Discharge Design

Once-through cooling water for the plant is supplied by gravity from Watts Bar Dam through a conduit system approximately 3,600 feet long. The centerline of the intake opening is located at elevation 716 feet and is contiguous with the upstream face of Watts Bar Dam at the right abutment of the dam. After passing through the condensers, the heated water is discharged via an open canal to a concrete drop structure (also known as a "morning glory") from which it is discharged into the river through a seven-foot wide by ten-foot high culvert. The culvert outlet has a top elevation of 675.0 feet which coincides with the minimum pool of Chickamauga Lake. Topography in the vicinity of the discharge area is given in Figure 6.

Discharge Rate and Temperature

When the plant is operated at rated capacity, the plant requires 626 cfs of cooling water and raises the temperature of water withdrawn through Watts Bar Dam by 10°F. Higher discharge rates of 775 cfs with correspondingly lower condenser temperature rises have been noted during water temperature surveys.

Because the elevation of the centerline of the turbines (elevation 676 feet, approximately 60 feet deep) is 40 feet below the steam plant intake, water temperatures entering the turbines in the dam could theoretically be lower than water temperatures entering the steam plant when Watts Bar Lake is stratified. A study of withdrawal layers into

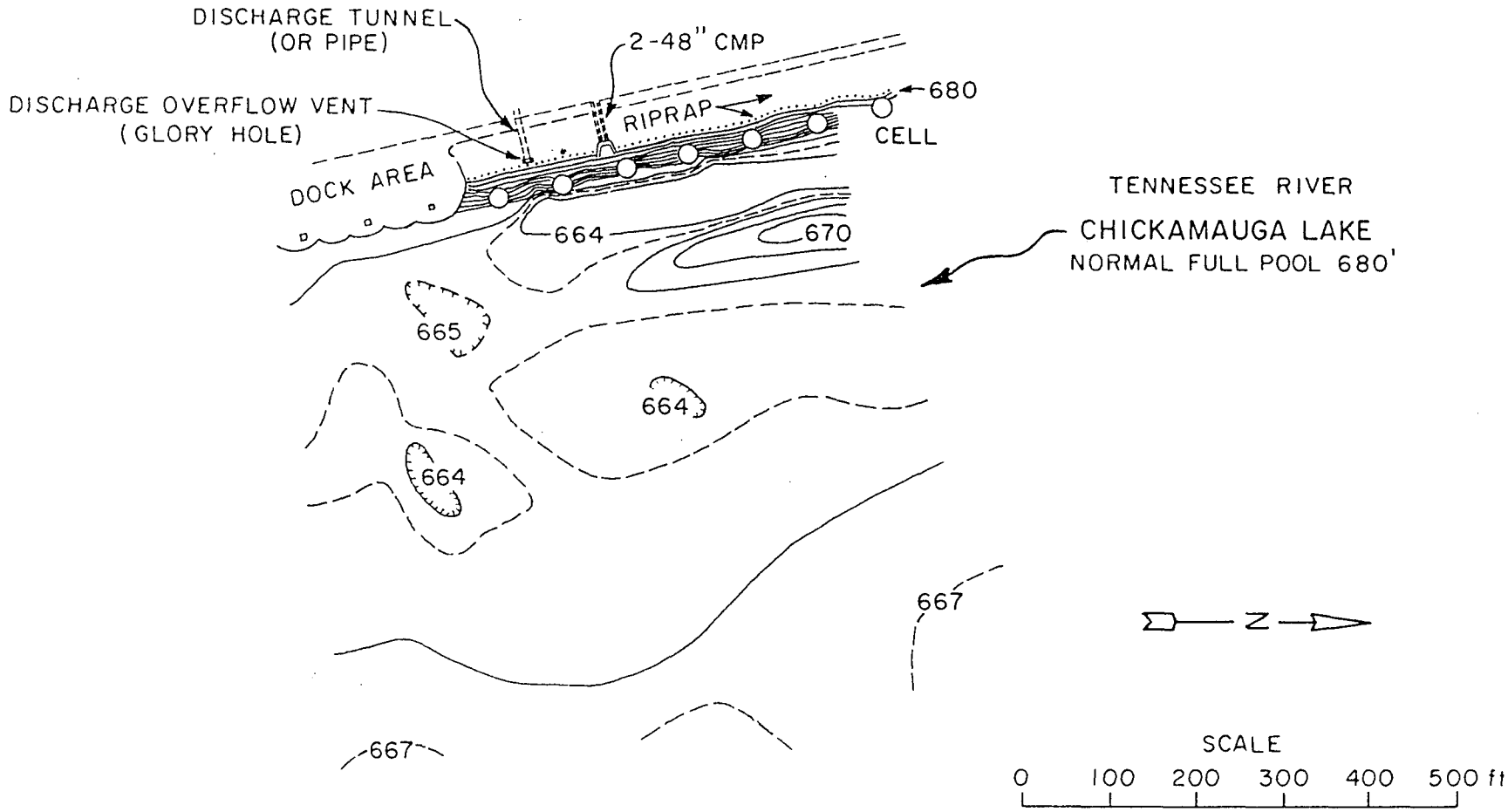


Figure 6: Condenser Water Discharge Area
Watts Bar Steam Plant

the turbines at Watts Bar Dam indicates that water from all depths enter the turbines, even when a warm surface layer is present in the summer months (Reference 7). Therefore the temperature of water entering the steam plant should be approximately equal to the temperature of water entering the turbines at Watts Bar Dam. The maximum 10°F condenser temperature rise at the Watts Bar Steam Plant is thus representative of the maximum difference between the steam plant discharge temperature and the river temperature before mixing.

NEAR-FIELD MIXING OF PLANT DISCHARGES

Watts Bar Nuclear Plant Diffuser

An analytical expression for the dilution induced by a submerged slot diffuser in shallow water was developed by Adams (Reference 8):

$$S = \tfrac{1}{2}(V \sin \gamma + (V^2 \sin^2\gamma + 2 \cos \theta)^{\frac{1}{2}}) \qquad (1)$$

where S = dilution

$$= \frac{\text{entrained river flow + diffuser flow}}{\text{diffuser flow}}$$

$$V = \frac{u_a h}{u_o B} = \frac{Q_R L}{Q_B w} = \text{volume flux ratio}$$

u_a = average river velocity across the diffuser

u_o = jet exit velocity

h = average river depth

B = slot width

Q_R = river flow at diffuser site = $u_a wh$

Q_B = diffuser flow = $u_o LB$

L = diffuser length

w = average river width

γ = orientation angle of diffuser in river (γ = 90°; perpendicular to river flow)

θ = discharge angle from river bottom (θ = 0°; parallel to river bottom)

Hydrothermal model tests discussed in Reference 2 showed that this equation could be used to conservatively predict the performance of the multiport diffuser system at the Watts Bar Nuclear Plant.

The two-dimensional structure of the discharge plume was predicted using the method of Jirka which is based on the theory of Adams (Reference 9). Full vertical mixing of the discharge plume and the receiving water was predicted for the following criterion:

$$F_T \, S^{3/2} \geq 1.0 \qquad (2)$$

where

$$F_T = \frac{F_s}{h/B^{3/2}} = \text{diffuser load}$$

F_s = slot densimetric Froude number

$$= \frac{u_o}{g'B}$$

$$g' = \frac{(\rho_o - \rho_a)g}{\rho_a}$$

ρ_o = density of discharge

ρ_a = density of ambient river water

g = gravitational constant

In general, stratified conditions downstream of the discharge were predicted when this criterion was not met. For the Watts Bar Nuclear Plant diffuser system, the variety of discharge conditions can result in either fully mixed or stratified conditions downstream of the discharge. For the maximum diffuser system flow, fully mixed conditions result.

Table 10 shows the design values of the diffuser parameters given in Equation 1. These design values correspond to the minimum Tennessee River flow of 3,500 cfs past the site and the maximum diffuser discharge of 170 cfs. Equation 1 predicts a diffuser-induced dilution of 16 for these conditions. Table 11 shows the expected mixed

Table 10

Design Values
Of Diffuser Parameters

Symbol	Parameter	Units	Design Value
Primary			
u_o	Discharge Velocity (max)	m/s (fps)	5.3 (17.3)
u_a	Average River Velocity	cm/s (fps)	4.9 (0.16)
B	Equivalent Slot Width	cm (ft)	1.33 (0.0436)
h	River Depth (min)	m (ft)	6.7 (22)
Secondary			
γ	Orientation Angle to River Flow	deg	90
Θ	Discharge Angle	deg	45
g'	Buoyancy (max)	$cm/sec^2(ft/sec^2)$	6.1(0.20)
	(min)	$cm/sec^2(ft/sec^2)$	-1.5(-0.05)
L	Diffuser Length (max)	m(ft)	69(225)
	(min)	m(ft)	23(75)
Analytical Theory (Reference 6)			
h/B	Submergence	--	505
V	Volume Flux Ratio	--	4.7
S	Dilution	--	16

Table 11

Expected Mixed Temperature Rise at
Edge of Diffuser Mixing Zone
Watts Bar Nuclear Plant

Month	Minimum	Average	Maximum
January	(0.3)[1]	1.2	2.3
February	(0.3)	1.3	2.0
March	0.0	1.2	2.3
April	0.3	1.1	1.9
May	-0.1	0.8	2.2
June	-0.3	0.6	1.4
July	-0.3	0.6	0.7
August	-0.3	0.4	1.1
September	-0.3	0.3	1.3
October	-0.5	0.4	2.0
November	-0.6	0.6	2.1
December	(0.1)	1.1	2.1
AVERAGE		0.8	

1. Parentheses indicate mixed temperature rises computed using blowdown temperatures based upon extrapolated cooling tower performance curves.

temperature rises at the edge of the area of diffuser-induced mixing using the initial temperature differences between the blowdown and the river before mixing shown in Table 9. Mixed temperature rises vary from -0.6°F in November to 2.3°F in January and March, averaging 0.8°F. Figure 7 shows the maximum expected mixed temperature rise as a function of river flow assuming an initial temperature difference between the blowdown and the river before mixing of 37°F in January and March.

The results of the hydrothermal model tests indicated there was no concentration of the discharge near the right bank. In addition, the discharge plume did not form a thermal wedge upstream of the diffuser even at the highest discharge buoyancy. In the model, the tendency of the discharge plume to form vertically mixed conditions downstream of the diffuser was well predicted by the theory of Adams. Similar plume structure is predicted for the actual diffuser design.

The results of the model tests showed that the expected diffuser-induced dilution was achieved approximately one diffuser length downstream. Thus, the area of diffuser-induced mixing extends approximately 160 feet downstream when the downstream leg of the diffuser system is discharging; approximately 80 feet downstream when the upstream leg of the diffuser system is discharging; and 240 feet downstream when both legs of the diffuser system are discharging. The proposed mixing zone should encompass all of these modes of operation and should extend 240 feet downstream over the entire river depth and diffuser system width (240 feet).

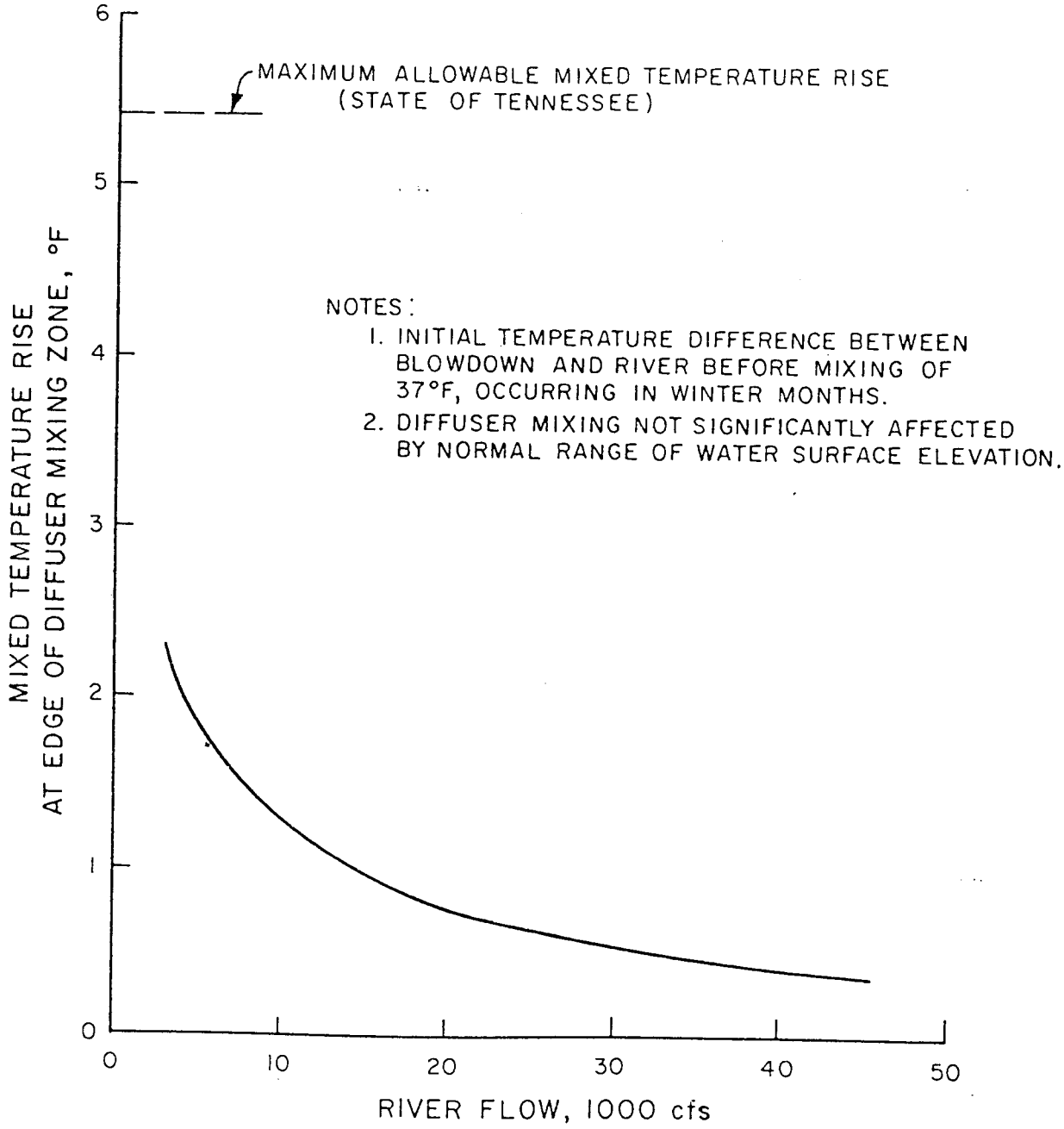


Figure 7: Maximum Mixed Temperature Rise
at Edge of Diffuser Mixing Zone
Watts Bar Nuclear Plant

WM28-1-85-100.7

Watts Bar Steam Plant Surface Discharge

Mixing With River Flow

The maximum initial temperature rise of 10°F above ambient of the surface discharge is reduced by turbulent mixing of the discharge with the receiving water. This mixing is a result of the relative velocity of the river, which is a function of the dam discharge and water surface elevation, and of the surface discharge, which has a maximum velocity of 9-11 fps perpendicular to the shoreline.

The dilution achieved by the steam plant discharge was modeled using the surface jet model of Shirazi and Davis (Reference 10). The maximum mixed temperature rise after initial mixing at the five-foot depth is shown on Figure 8 as a function of river flow and water surface elevation. The maximum temperature rise of 5°F occurs on the plume centerline at a river flow of 5000 cfs and a water surface elevation of 675.0 feet. The average temperature rise of the plume for these conditions is 3°F. This average is computed assuming a Gaussian lateral temperature distribution and a plume width of four standard deviations (Reference 10). The maximum mixed temperature rises shown in Figure 8 occur in the winter months when ambient river temperatures are below 50°F. When ambient river temperatures are higher than 50°F, the mixed temperature rises can be as much as 0.5°F lower than those in Figure 8. Mixed temperature rises are larger in the winter because of the non-linear, density-temperature relationship for water.

The size of the initial mixing region for the steam plant discharge depends on the magnitude of the river flow, but the region does not extend more than 300-800 feet from the discharge point.

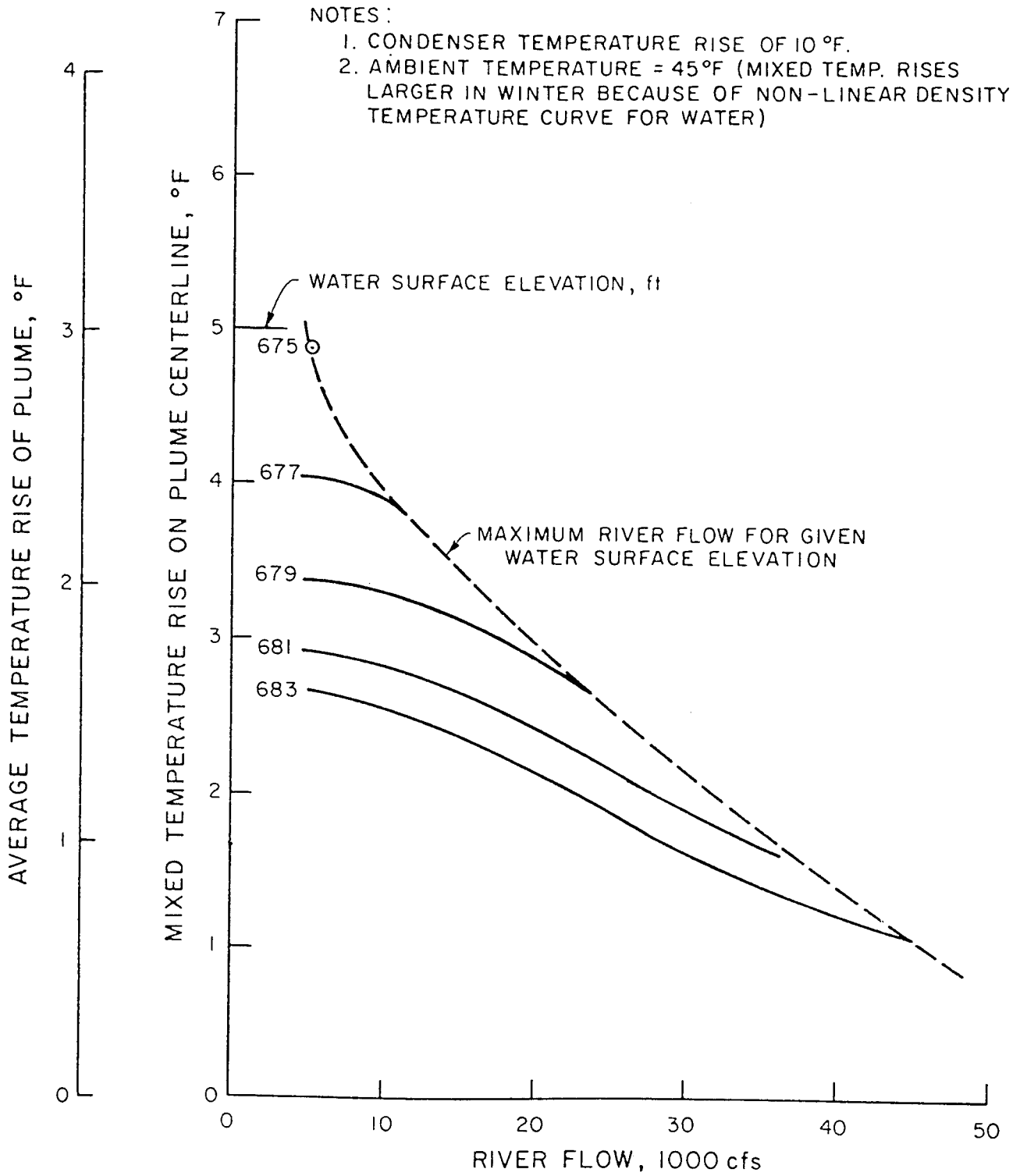


Figure 8: Maximum Mixed Temperature Rise After Initial Mixing at the Five Foot Depth Watts Bar Steam Plant

The effect of river flow is to deflect the heated plume, confining its influence to a zone extending along the right bank of the river. The lateral extent of the induced temperature distribution increases with decreasing river flow. The induced temperature distribution in the river is very weakly stratified except in the region near the discharge. The combination of the relatively shallow river depth (10-20 feet) and the intense mixing induced by the discharge results in nearly complete vertical mixing.

Reference 4 discusses field observations of water temperatures downstream of the steam plant discharge during steady river flow. Dilution of the discharge was well predicted by the surface jet model of Shirazi and Davis (Reference 10).

Mixing Without River Flow

As previously mentioned, periods of no river flow can last as long as 12 hours because of the operation of Watts Bar Dam for peaking power purposes. During a shutdown of river flow, heated water is not convected away from the vicinity of the steam plant discharge and is reentrained in the mixing process, causing a gradual increase in temperatures in the vicinity of the plant.

Previous studies have shown the rate of temperature increases in the vicinity of the steam plant for no river flow periods of up to six hours (Reference 4). Immediately after shutdown, initial surface jet mixing reduced the maximum condenser temperature rise of 10°F to about 2-3°F. After six hours of shutdown, the temperature rise after surface jet mixing was about 3-4°F. The downstream and upstream extent of the temperature buildup was also time dependent with the

2°F isotherm shifting approximately 1000-1500 feet upstream during the six-hour shutdown. No extensive measurements of the warm water slug downstream of the steam plant were made. Temperature rises of less than 1°F were found downstream of the proposed nuclear plant discharge at TRM 527; however, these are primarily attributable to previous periods of steam plant discharge in the presence of river flow.

A study of the extent of temperature buildup caused by the steam plant discharge during a river flow shutdown of 12 hours duration were conducted on October 30, 1977, with all four steam plant units in operation. Figure 9 shows the longitudinal excess temperature distribution of the warm water slug compared to that of the previous study with a six hour shutdown. The effect of extended durations of river shutdown is to increase the longitudinal extent of the warm water slug downstream rather than the maximum temperature increase of the warm water slug. The downstream edge of the warm water slug proceeded downstream as a stratified surface layer, causing less than a 1°F temperature rise in the vicinity of the proposed nuclear plant discharge at TRM 527.8. Figure 9 shows that temperature measurements in the immediate vicinity of the steam plant discharge fluctuated between 2.5°F and 4.0°F, probably due to the high turbulence in the vicinity of the discharge. No significant difference occurred in the upstream longitudinal temperature distribution between the 6- and 12-hour shutdown. Apparently, the temperature distribution upstream of the steam plant discharge reaches a steady state condition after approximately six hours of no river flow.

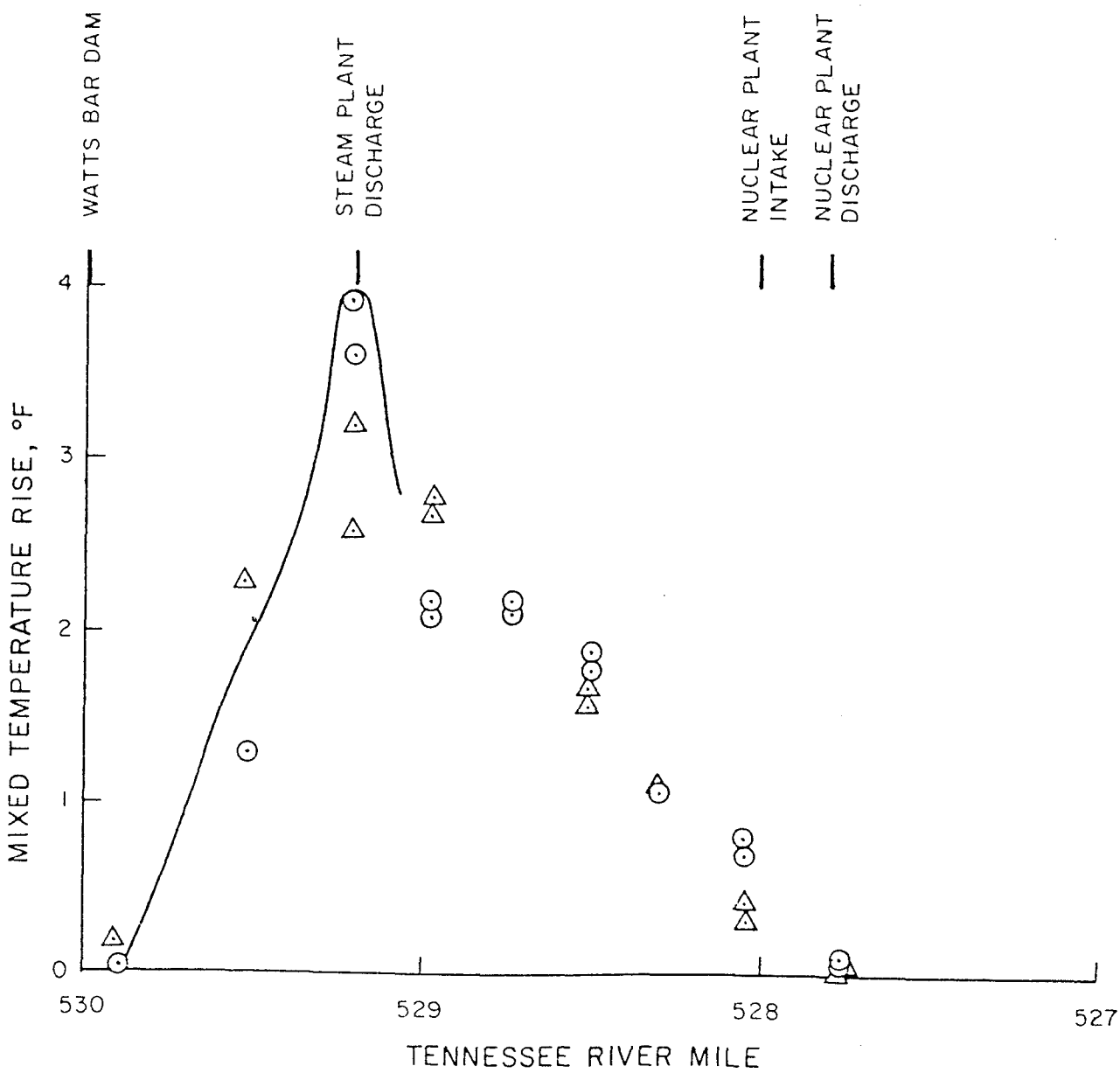


Figure 9 : Longitudinal Excess Temperature Distribution Below Watts Bar Dam After Periods of Steam Plant Discharge and No River Flow

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Combined Near Field Effect of Plant Discharges

Mixing With Steady River Flow

The combined mixed temperature rise of the Watts Bar Nuclear and Steam Plants at the downstream edge of the diffuser mixing zone can be calculated for steady river flow by adding the individual mixed temperature rises after near-field mixing for each case. The average mixed temperature rise of the steam plant plume is used because it is representative of the ambient temperature of water entrained by the nuclear plant diffuser. Water temperature surveys of the steam plant plume show that it hugs the right bank with the warmest temperatures occurring near the bank (Reference 4). Hydrothermal model tests of the nuclear plant diffuser showed no concentration of the diffuser discharge near the right bank (Reference 2). Lateral mixing in the river between the plants and turbulent diffuser mixing will result in a fairly uniform lateral temperature distribution at the downstream edge of the diffuser mixing zone.

Figure 10 shows the maximum mixed temperature rise at the five-foot depth of the combined plant discharges using the mixed temperature rises for the nuclear and steam plants in Figures 7 and 8, respectively. The maximum temperature rise for any flow or elevation is shown to be less than the maximum allowable temperature rise of the State of Tennessee of 5.4°F.

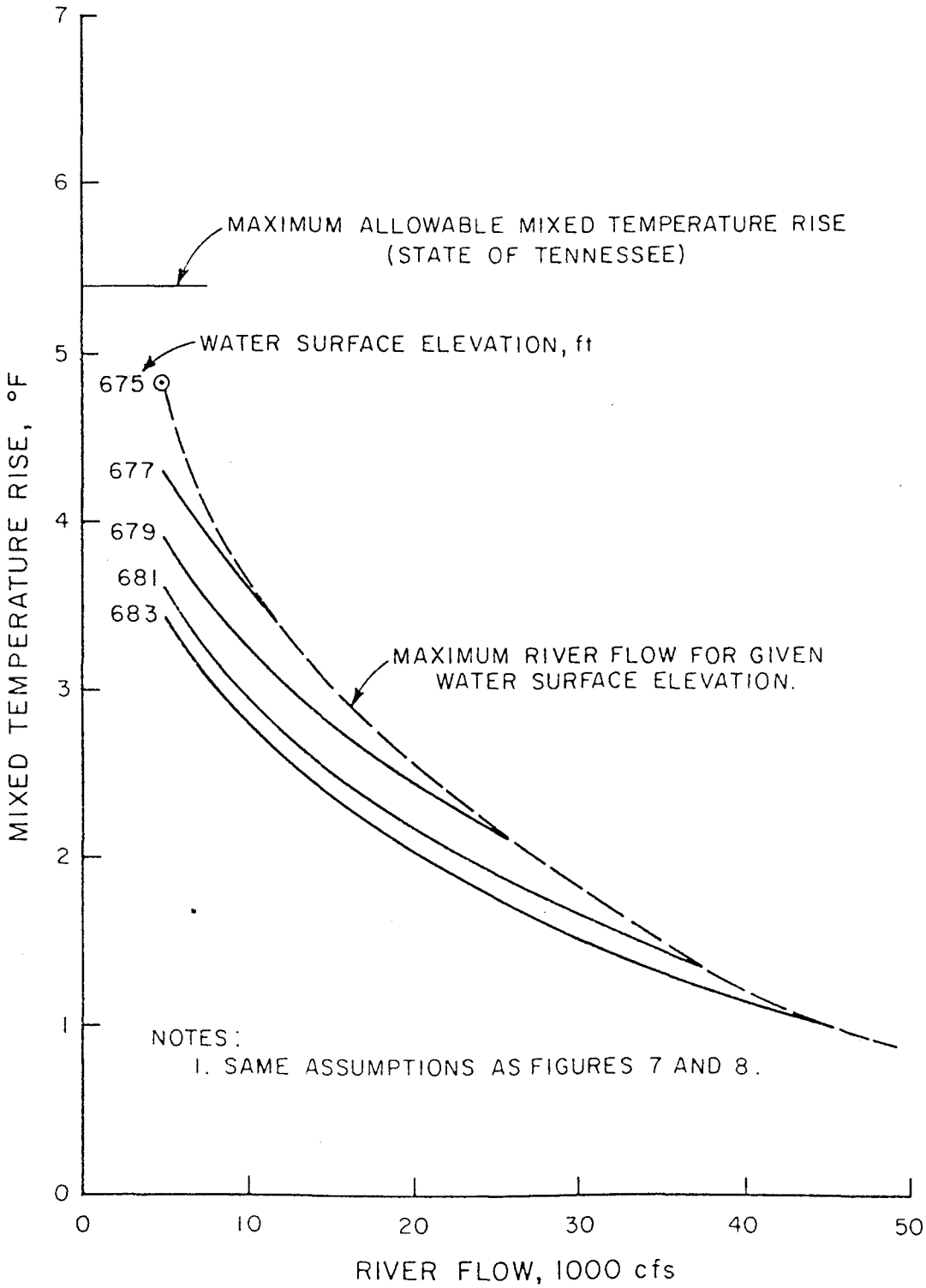

Figure 10: Maximum Mixed Temperature Rise at the Five Foot Depth After Initial Mixing Watts Bar Steam and Nuclear Plant

WM28-1-88-100.10

Mixing After Periods of No River Flow

The resumption of dam discharges following shutdown periods will advect the warm water slug discharge from the Watts Bar Steam Plant during the shutdown period past the Watts Bar Nuclear Plant diffuser. Blowdown will be discharged through the nuclear plant diffuser when the dam resumes operation and will entrain this warm water in the mixing process. Higher mixed temperature changes and rates of temperature change can occur.

Temperature changes and rates of temperature change immediately following no release periods at Watts Bar Dam were analyzed using an advection model for the movement of the warm water slug downstream. The mixing of the nuclear plant diffuser and the steam plant surface discharge after the resumption of river flow were analyzed as discussed previously.

Model Assumptions--The assumptions for the model were the following:

1. River flow and elevation at the downstream edge of the diffuser mixing zone were the same as the flow and elevation at the tailwater of Watts Bar Dam, with an appropriate time delay to account for the travel time of discharge waves from the dam.
2. River velocity was computed using cross-sectional areas derived from field measured flow and velocity data according to the relation:

$$A = (z-z_0)\ b$$

where A = cross-sectional area

z = water surface elevation

z_o = bottom elevation downstream of diffuser

= 661.0 feet

b = effective flow-carrying river width

≅ 800 feet

3. Maximum discharge rates and temperature rises from the steam and nuclear plants (Figures 7 and 8).
4. The initial temperature distribution of the warm water slug after 12 hours of no discharge from the dam was used neglecting the scattered temperature measurements in the immediate vicinity of the steam plant discharge (Figure 9). An average of the temperatures measured at the discharge point was used in developing a curve fit for the initial temperature distribution.
5. No surface heat loss from the river.
6. No dispersion of the warm water slug in the river.
7. Water temperature changes and rates of change attributable to the steam and nuclear plants are calculated as the difference in the measured water temperatures of water discharged through Watts Bar Dam and water at the downstream edge of the nuclear plant diffuser mixing zone.

For an input set of flow and elevation data, the model computes the temperature change and rate of temperature change every minute at a selected point of interest in the vicinity of the nuclear plant diffuser. The resulting temperature history can be analyzed for the maximum temperature rises and rates of rise.

Model Verification--Figure 11 shows a comparison of model results with measured data taken at TRM 527.8 after the resumption of river flow following a 12-hour river flow shutdown on October 30, 1977. Shown for reference on Figure 11 are the measured velocities near the surface and bottom during the survey. Low surface velocities existed before the resumption of dam discharges and signaled the arrival of a warm surface layer caused by the steam plant discharge. At higher river flows after 1300 hours, the velocity distribution was uniform with near-surface and near-bottom velocities of similar magnitude.

Figure 11 shows that the computed temperature history at the five-foot depth compares reasonably well with the measured temperature history at the same depth. The maximum temperature change and rate of change predicted by the model in Figure 11 were 2.7°F and 1.5°F/hr, respectively, compared to the measured values of 2.7°F and 1.8°F/hr, respectively. This comparison suggests that the model be used with an error margin for the rate of temperature change of about 0.3°F/hr. This margin would be expected to be smaller at higher flow rates when the rate of temperature change is limited by the maximum possible temperature change. The rate of temperature change was over predicted by the model after the passage of the center of the warm water slug. This is caused by the conservative assumption neglecting dispersion of the warm water slug in the river. The arrival time of the center of the warm water slug and the steady-state temperature rise of the steam plant discharge (using the plume average temperature rise in Figure 8) were well predicted by the model.

Model Results--Calculations of the maximum rate of temperature change at various water surface elevations and river flows were made

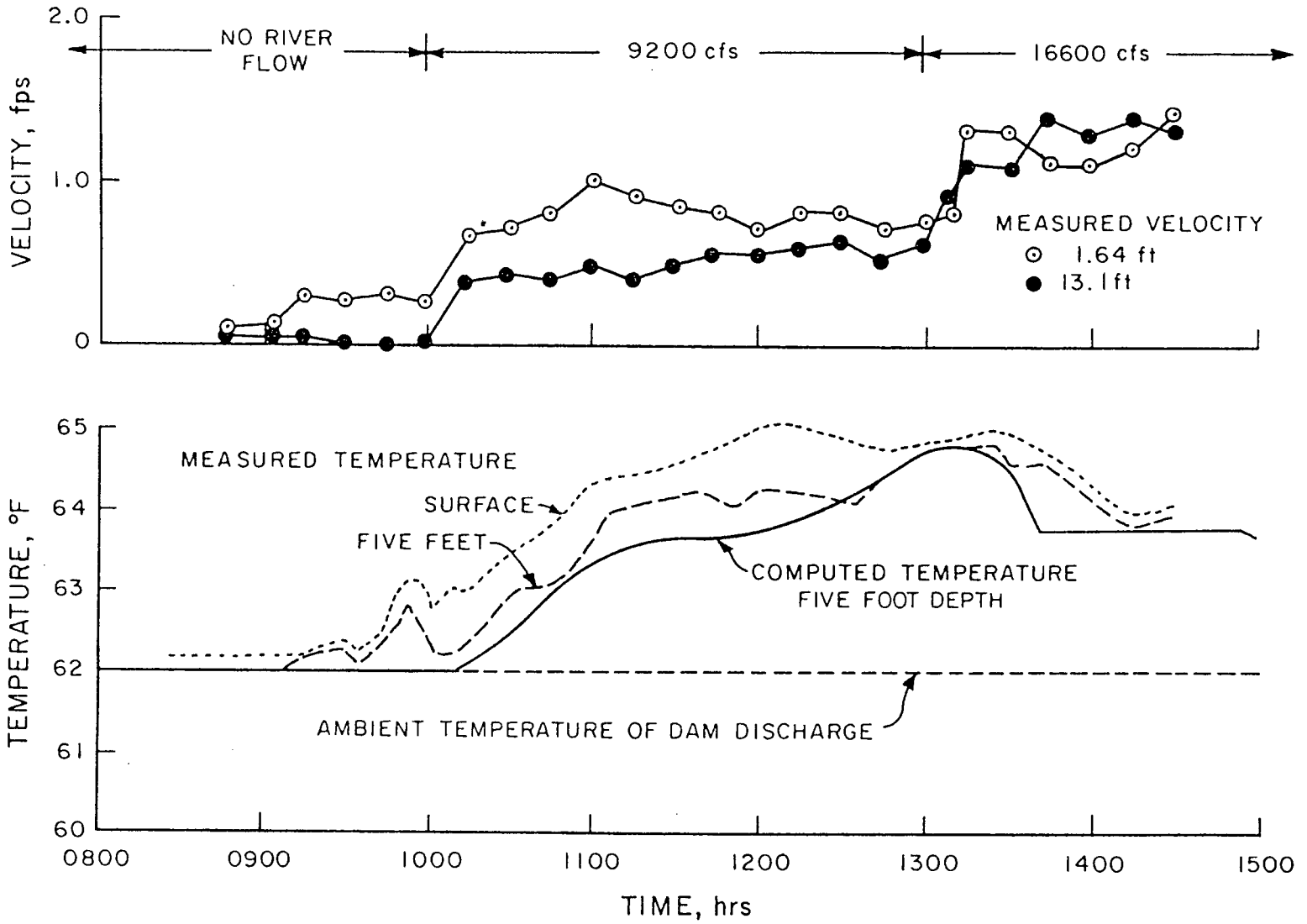

Figure 11: Velocity and Temperature at TRM 527.8, October 30, 1977
After 12 hrs of No Flow at Watts Bar Dam

using the model. Figure 12 shows that the maximum rate of temperature change was 2.7°F/hr when the nuclear plant was not in operation immediately following a 12-hour river flow shutdown. The maximum rate of change was reached at river flows greater than approximately 25,000 cfs and was limited by the maximum possible temperature rise in the warm water slug after 12 hours of no river flow.

Figure 13 shows that the maximum rate of temperature change was 3.3°F/hr when the nuclear plant was in operation immediately following 12 hour river flow shutdowns. The maximum rate of change was reached at river flows greater than approximately 25,000 cfs and was limited by the maximum possible temperature rise in the warm water slug and the maximum possible mixed temperature rise due to the nuclear plant discharge at river flows greater than 25,000 cfs.

The maximum rates of temperature change for steady river flows in Figure 13 are also the limiting rates of temperature change for normal startup conditions at Watts Bar Dam. These normal conditions are an increasing or steady number of turbines in operation, such as two units the first hour, three units the second hour and five units in succeeding hours. The only startup condition which was found to cause higher rates of temperature change were four units in the first hour and one unit in the second hour. This higher rate of temperature change could occur with an unlikely startup condition at Watts Bar Dam after a maximum shutdown period of 12 hours, maximum operation of Watts Bar Steam Plant and maximum operation of Watts Bar Nuclear Plant during the winter months with below normal river temperatures and above normal wet bulb temperatures. Thus, Figure 13 represents the maximum rate of temperature change to be expected downstream of the Watts Bar Nuclear Plant.

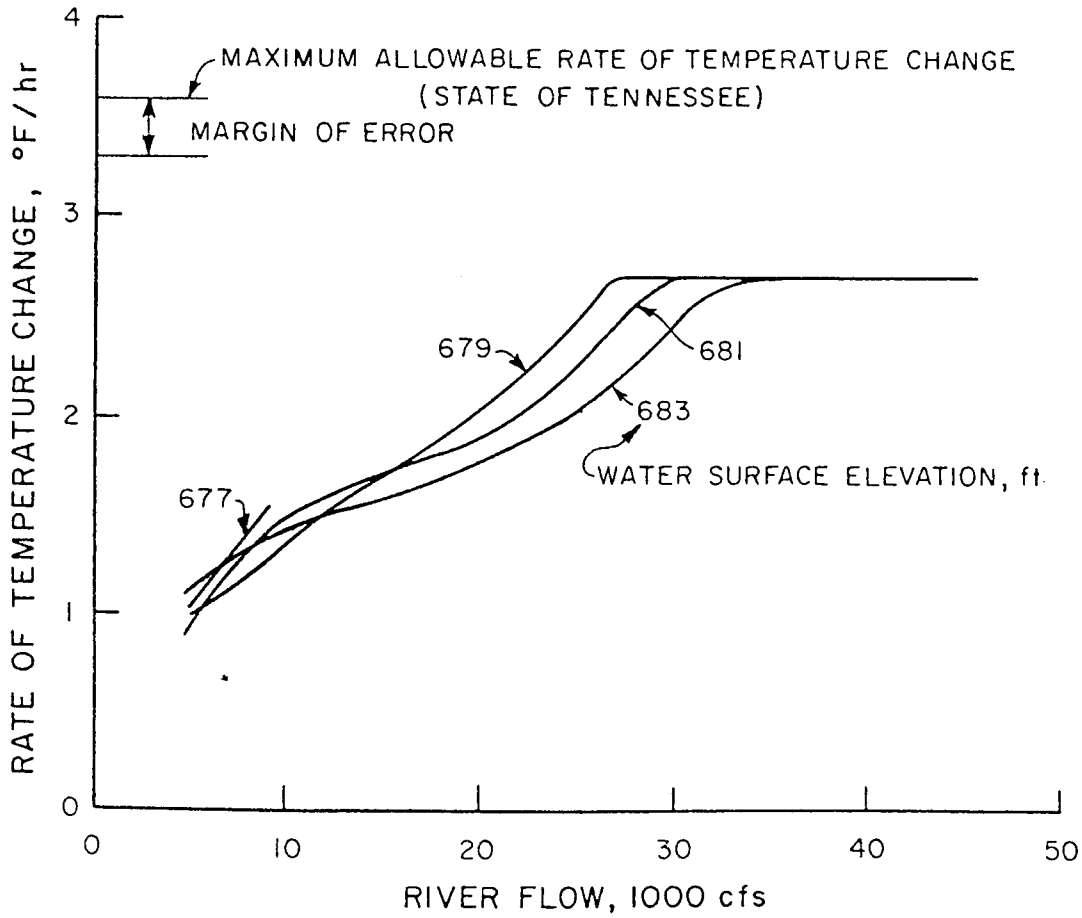

Figure 12 : Maximum Rate of Temperature Change
Following 12 hr River Flow Shutdown
Watts Bar Steam Plant

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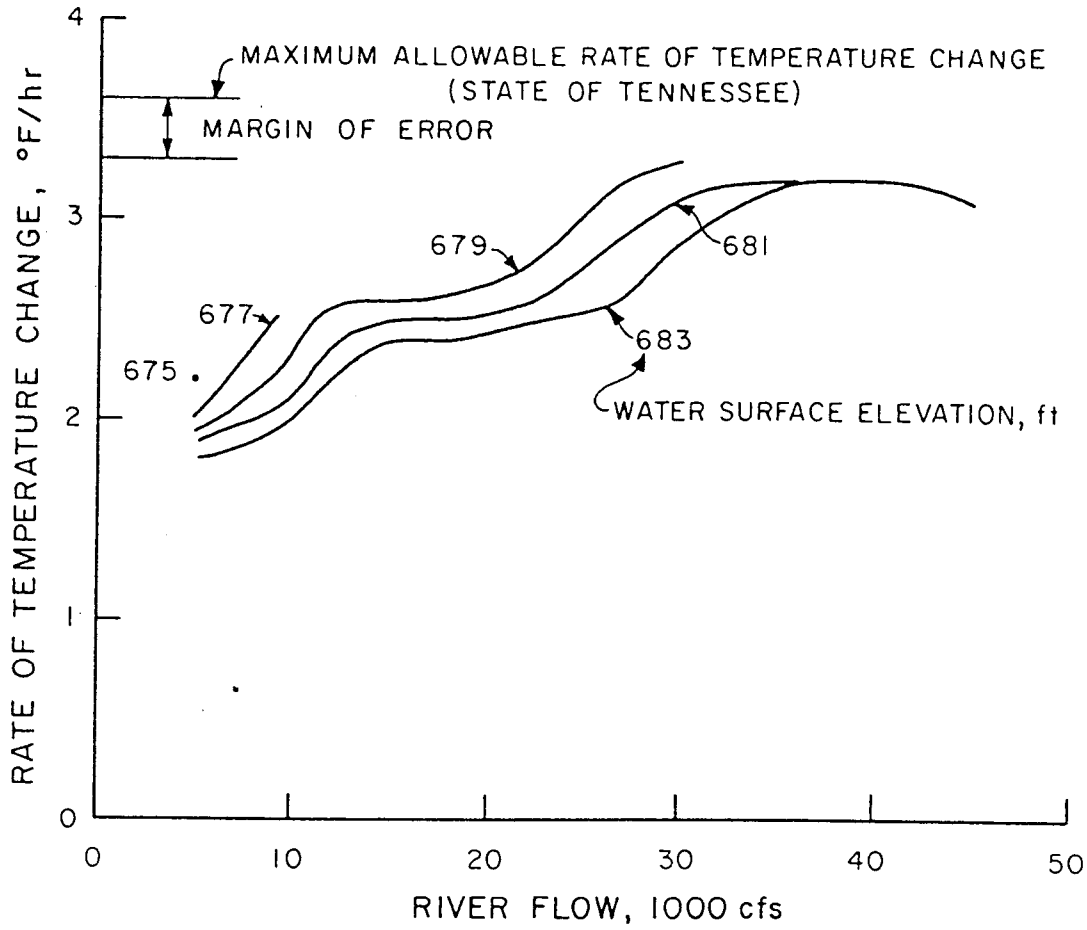

Figure 13 : Maximum Rate of Temperature Change
Following 12 hr River Flow Shutdown
Watts Bar Nuclear and Steam Plants

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EVALUATION OF COMPLIANCE WITH THERMAL STANDARDS

Maximum Water Temperature

Discharges from the nuclear and steam plants will not cause a mixed temperature in the river greater than 86.9°F (30.5°C), except when tailrace temperatures at Watts Bar Dam approach or exceed 86.9°F (30.5°C). The discharge temperature from nuclear and steam plants may exceed 86.9°F in the months of April or May through October, and the tailrace temperature at Watts Bar Dam may approach 86.9°F in the months of June through September. Thus, if the tailrace temperature approaches or exceeds 86.9°F, the mixed temperature in the river may exceed 86.9°F due in part to the thermal discharges from the plants.

Maximum Water Temperature Change

The maximum mixed temperature rise caused by the nuclear plant diffuser discharge is 2.3°F in January and March (Figure 7). Thus, the diffuser discharge at the five-foot depth on the downstream edge of the diffuser mixing zone from the Watts Bar Nuclear Plant alone will not cause a water temperature change greater than 5.4°F (3°C) under any flow or meteorological condition.

The maximum mixed temperature rise caused by the steam plant surface discharge at the five-foot depth on the downstream edge of the diffuser mixing zone is 2.9°F during the winter months (Figure 8). The corresponding maximum temperature rise at the five-foot depth on the steam plant plume centerline is 4.9°F in the vicinity of the steam plant discharge. Thus, the surface discharge from the Watts Bar Steam

Plant alone will not cause a water temperature change greater than 5.4°F (3°C) under any flow or meteorological condition.

The maximum mixed temperature rise caused by the combined steam and nuclear plant discharge during steady river flows at the five-foot depth at the downstream edge of the diffuser mixing zone is 4.9°F during the winter months (Figure 10). The maximum mixed temperature rise caused by a warm water slug discharged by the steam plant during a 12-hour river flow shutdown is 2.7°F during the periods immediately following the resumption of river flow (Figure 11). The resumption of discharge from the nuclear plant immediately following this shutdown period would cause a total maximum water temperature change of 5.0°F (Figures 7 and 11). Thus, the combined operation of the Watts Bar Nuclear and Steam Plants will not cause a water temperature change greater than 5.4°F (3°C) under any flow or meteorological condition.

Maximum Rate of Temperature Change

Because the maximum mixed temperature rise caused by the nuclear plant discharge at the downstream edge of the diffuser mixing zone is 2.3°F, the maximum rate of change of temperature caused by the Watts Bar Nuclear Plant discharge alone will not exceed 3.6°F (2°C) per hour. Because the maximum mixed temperature caused by the steam plant discharge at the downstream edge of the diffuser mixing zone is 2.9°F, the maximum rate of change of temperature caused by the Watts Bar Steam Plant alone will not exceed 3.6°F (2°C) per hour.

If the steam plant and nuclear plant begin discharging at a time such that their respective discharges arrive at the downstream edge of the diffuser mixing zone within an hour of each other, the rate of

rate of temperature change could exceed 3.6°F (2°C) per hour. Because the steam plant, due to its age, must increase from zero to full power very gradually, and because the temperature difference between the nuclear plant discharge and river is unlikely to be at its maximum expected value, it is not expected that a maximum rate of temperature change in excess of 3.6°F (2°C) per hour will occur for this condition.

The maximum rate of temperature change caused by the passage of a warm water slug discharged by the steam plant during a 12-hour river flow shutdown is 3.3°F/hr during the period immediately following the resumption of river flow with the nuclear plant in operation (Figure 13). This value is 2.7°F/hr without the nuclear plant in operation (Figure 12). Thus, the combined operation of the steam and nuclear plants during this condition will not cause a rate of temperature change greater than 3.6°F (2°C) per hour.

Mixing Zone and Temperature Monitors

The proposed mixing zone for the nuclear plant should extend 240 feet downstream over the entire river depth and diffuser system width (240 feet) and should encompass all modes of operation of the discharge system.

Water temperatures measured near the downstream edge of the nuclear plant mixing zone and in the turbine discharge of Watts Bar Dam should be used to show the combined effect of the Watts Bar Nuclear and Steam Plants.

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3. TVA Memorandum to E. H. Lesesne, Director of Water Management, from R. H. Dunham, Director of Engineering Design, "Watts Bar Nuclear Plant, Units 1 and 2, Multiport Diffuser Design, Revision of Discharge Flows," October 20, 1977.

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ATTACHMENT

Question 7

Table 2-2

DILUTION FACTORS AND TRAVEL TIMES FOR DOWNSTREAM WATER USERS WITHIN AN 80.5-5 KILOMETER (50-MILE) RADIUS

Water User	Location	Travel Time (days)	Dilution Factor
Watts Bar Nuclear Plant	TRM 528.8R	NA	NA
Dayton, TN	TRM 503.8R	1.8	204
Soddy-Daisy Falling Water U.D.	TRM 487.2R Soddy CK 4.0	3.0	272
Sequoyah Nuclear Plant	TRM 483.6R	3.3	282
U.S. Army Volunteer Ammunition Plant	TRM 473.0L	4.0	307
Chickamauga Dam	TRM 471.0	4.2	*
E.I. DuPont Company	TRM 469.9R	4.2	*
Tennessee-American Water	TRM 465.3L	4.6	*
Rock-Tennessee Mill	TRM 463.5R	4.7	*
Dixie Sand and Gravel	TRM 463.2R	4.7	*
Chattanooga Missouri Portland Cement	TRM 456.1R	5.2	*
Signal Mountain Cement	TRM 454.2R	5.4	*
Raccoon Mountain Pump Storage	TRM 444.7L	6.1	*
Signal Mountain Cement	TRM 433.3R	6.9	*
Nickajack Dam	TRM 424.7	7.5	*
South Pittsburgh, TN	TRM 418.0R	8.0	*
Bridgeport, AL	TRM 413.6R	8.3	*
Widows Creek Steam Plant	TRM 407.7R	8.7	*
Mead Corporation	TRM 405.2R	8.9	*

*River is assumed to be fully mixed downstream of the Chickamauga Dam; dilution factor equals 448.

ATTACHMENT

Question 8

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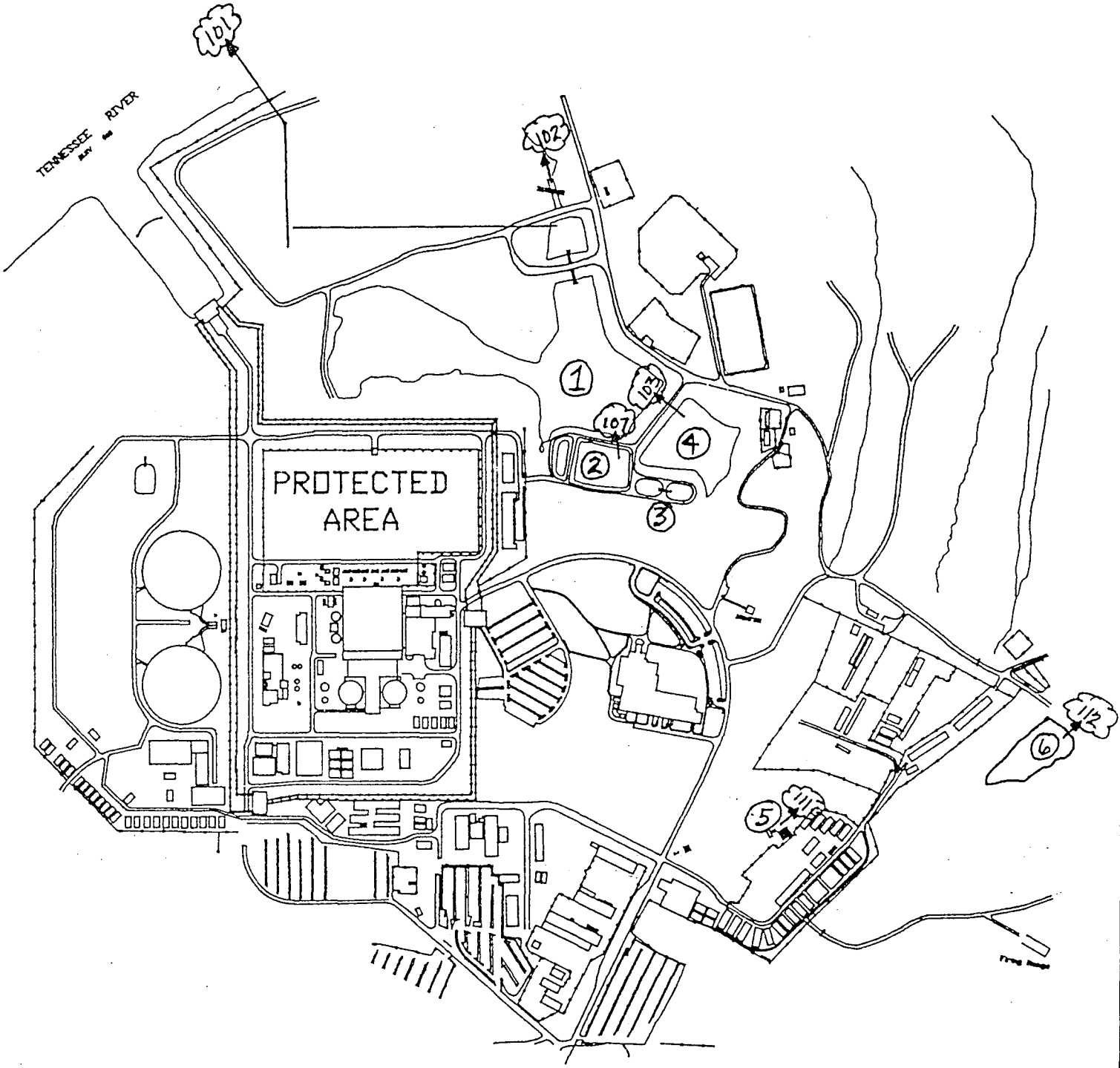
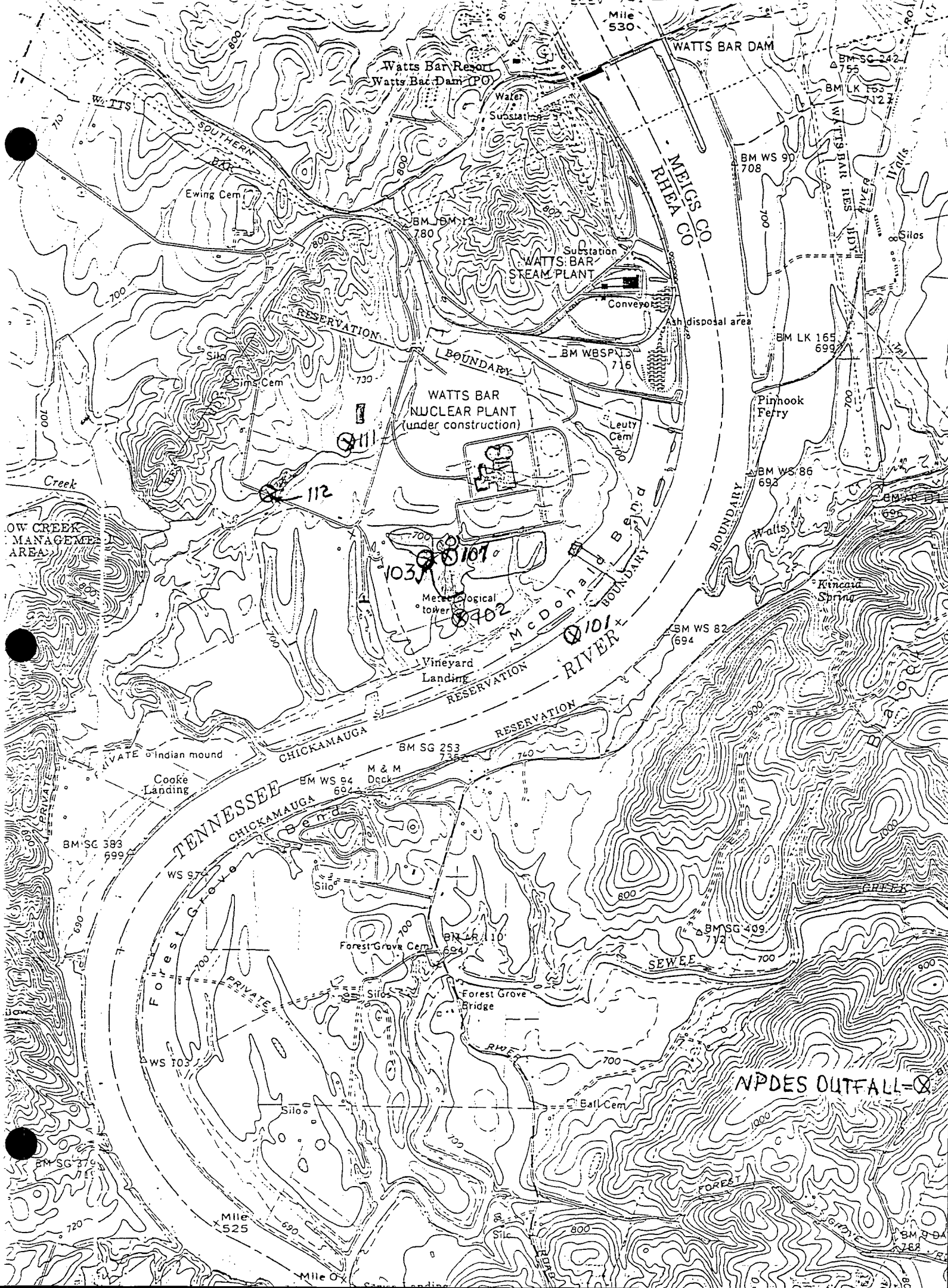
WATTS BAR NUCLEAR PLANT
PREFIRE PLANS



1. YARD HOLDING POND
2. METAL CLEANING WASTE PONDS
3. ALUM SLUDGE PONDS
4. LOW VOLUME WASTE TREATMENT POND
5. SEWAGE TREATMENT PLANT
6. CONSTRUCTION RUNOFF HOLDING POND

101 – OUTFALLS


Mile 530
WATTS BAR DAM
Watts Bar Resort
Watts Bar Dam (PO)
Water Substation
WATTS
SOUTHERN
BAR
Ewing Cem
BM BM 13 780
MEIGS CO
RHEA CO
BM WS 90 708
WATTS BAR RES
RIVER
Silos
Substation
WATTS BAR STEAM PLANT
Conveyor
Ash disposal area
RESERVATION
BOUNDARY
BM WBSP 716
BM LK 165 699
Silo
Sims Cem
WATTS BAR NUCLEAR PLANT (under construction)
Pinhook Ferry
Leuty Cem
BM WS 86 693
Creek
112
111
107
103
Meteorological tower
102
McDonald Bend
BOUNDARY
Kincaid Spring
101
BM WS 82 694
Vineyard Landing
RIVER
RESERVATION
CHICKAMAUGA
BM SG 253 736
Indian mound
Cooke Landing
BM WS 94 694
M & M Dock
TENNESSEE
CHICKAMAUGA
Bend
BM SG 383 699
WS 97
Silo
Forest Grove
Forest Grove Cem
BM LK 110 694
BM SG 409 712
SEWEE
PRIVATE
Silos
Forest Grove Bridge
WS 103
NPDES OUTFALL
Ball Cem
BM SG 370
FOREST
Mile 525
Mile 0
Sequoyah Landing

ATTACHMENT

Question 9

WATTS BAR NUCLEAR PLANT

Transmission lines that relate to the Watts Bar Nuclear Plant include:

- Sequoyah-Bull Run 500 kV loop to Watts Bar Nuclear
- Sequoyah-Watts Bar number 2 500 kV
- Watts Bar Fossil-Watts Bar Nuclear Plant numbers 1 and 2 161 kV
- Watts Bar-Volunteer 500 kV
- Watts Bar Roane 500-kV

These lines are located in mildly to steeply rolling terrain that includes some of the ridge and valley geologic province. The lines were constructed and have been maintained for a number of years predominantly by mechanical reclearing since most of the easements are used for semi- to open farmland pasture or row crops; for access by property owners to small wood lots or hunting areas; or are in urban and built-up zones that have expanded around Knoxville, Oak Ridge, Kingston, Ft. Loudoun, and Lenoir City. Reclearing was conducted in 1987 and 1990 by predominantly mechanical or hand-clearing methods. TVA is actively examining use of chemical selective control on limited portions that includes steep terrain, non-agricultural wood lots, fence rows, and small, scattered island wood lots.

The selective liquid spray applications being considered consist of Accord or Accord-Arsenal mixtures. The application would require small amounts of low-volume basal or aerial application which would be much less physically damaging to crops (due to access of equipment) and much more efficient to TVA right-of-way operations. Their use would also significantly reduce potential for chain saw, axe, and other mechanical or hand equipment injuries to personnel without significantly affecting farming, semi-urban, or wildlife interests as documented in U.S. Forest Service Environmental Impact Statements for vegetation management in the Appalachians, Ozarks, and Piedmont.

The fiscal year 1995 reclearing effort on the lines will be by mechanical means except for a portion of the ridge section of Watts Bar-Volunteer where slopes preclude use of mechanical equipment under revised OSHA personnel protection requirements. Hand cutting or low volume liquid application is used on those slopes where mechanical clearing cannot be performed.

In those segments where herbicide could be used, TVA Transmission Power Supply (TPS) and Customer Group (CG) Right-of-Way Program Administrators and Technical Support personnel consult EPA/USDA/USFWS endangered species county brochures to determine if the selected herbicides are listed as potential exposure problems for any endangered or threatened listed species. If herbicides are potential problems, TVA's Resources Group (RES) personnel are consulted to determine if the species or habitat is on the ROW or immediately adjacent. If they are, the recommendations for buffer zones are considered based on methods of herbicide application. In all cases to date, TVA policy buffer zones are more protective of the species and/or habitat.

TVA also reviews the lines for other sensitive areas, potential conflicts, new additions of designated environmental historic or recreational interest, etc., and these reviews are factored into the planning and buffer zone placement.

nnessee Valley Authority
of Power System Operations

TVA

Transmission Line Maintenance Manual

RIGHT-OF-WAY MAINTENANCE

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HERBICIDE USE

Herbicides are an important component of our right-of-way maintenance and reclearing program. The Customer Group uses only herbicides that have been approved and registered by the Environmental Protection Agency. Before using any herbicide, the supervisor reads the entire label, discusses with supervised employees, and provides any additional written instruction necessary to ensure employees follow all instructions on usage of product, storage of product, and disposal of containers. Close coordination between the Customer Service Centers and the Transmission Support Department (TSD) is necessary to ensure that all employees making herbicide applications are properly trained in how to use the chemicals. All Right-of-Way Program Administrators should have commercial certification in the right-of-way category, and line crew personnel should have private applicators license. Transmission Support will furnish herbicide training to personnel upon request. While this section of the manual provides guidelines for the application of herbicides, a good common sense approach to the use of herbicides is a must. Some of the advantages of using herbicides are that the number of woody stems are reduced, making future maintenance cost less, and employees can remove undesirable vegetation without being exposed to the hazards associated with power saws, falling trees, and rotary cutting equipment. Also, the time between reclearing cycles can generally be increased when herbicides are used instead of mechanical clearing. In addition, limited sport follow-up treatment can deal with some regrowth or missed spots without the extra cost of another reclearing operation.

The areas of right-of-way to be chemically treated must be selected by the Customer Service Center Manager or line foreman in conjunction with the Program Administrator. It is the Customer Service Center Manager's responsibility to develop a plan for large herbicide applications, though no written plan is required for spot applications in conjunction with line inspections or maintenance. Documentation of all treatment is required. Limiting the number of people selecting areas to use herbicides should minimize the number of damage claims resulting from the misuse of herbicides. Before using any herbicide, the applicator and his supervisor must read the label attached to the container, follow all application rates and safety instructions listed on the container label, and be sure that the application will not damage any desirable vegetation in the area. All employees who apply herbicides should receive annual training and have a private applicators license. <u>Listed below are areas where herbicides should never be applied</u>.

1. Near crops, gardens, and other valuable vegetation (200 feet).

2. Picnic and camping areas.

3. Aerial application within 200 feet of ponds, streams, and other water sources, unless specifically labeled for wetlands.

4. Ground application within 50 feet of above sources, unless specifically labeled for wetlands.

5. Subdivision lawns or within 300 feet of any residence.

6. During rainy periods or during the 24-hour interval prior to rainfall predicted with a 40 percent or greater probability by local forecasters, soil active herbicides should not be applied.

7. Trees that could hit a conductor or support structure.

8. Areas highly visible from interstates and other heavily traveled highways and roads or scenic tracts and designated scenic areas.

9. In fence rows and other areas where cattle might eat wilted cherry leaves.

10. In city, state, and national parks and forests without written permission and/or required permits from the proper public officials.

11. In areas where soil erosion might occur or soil might be mechanically relocated, when soil-active herbicides are used.

12. Off the right-of-way.

13. Without permission of the property owner on property leased or rented to TVA.

The aerial application of herbicides is usually the best method when remote, inaccessible zones, widely spread intermittent zones on the same right-of-way, or large areas of right-of-way are to be treated. Helicopters can be equipped with micro-foil through valve, or meter rate booms to accurately apply liquid, granule, or pellet-formulated herbicides. Most liquid herbicides are intended for foliar application; therefore, they must be applied when the plant's foliage is full and most active--normally May through July. Application of liquid herbicides should never be made when the wind velocity exceeds five miles an hour, in areas where fog exists, when the air temperature exceeds 95°F, or during periods of temperature inversion. Following these guidelines will minimize off right-of-way damage due to herbicide drift. The optimum time to apply soil-active herbicides is late fall and early spring, prior to spring and summer root uptake. However, soil-active herbicides may be applied at any time of year, but never when the wind velocity exceeds 10 miles an hour, on frozen or water-saturated soil, or near the edge of the right-of-way (25 feet) where off right-of-way vegetation roots might encroach into the treated area. A preflight walking or flying inspection must be made within 72 hours prior to applying herbicides aerially. This inspection should ensure that no land use changes have occurred, that sensitive areas are clearly pointed out to the pilot, and the proper buffer zones are maintained.

Application of herbicides by ground crews is usually the best method when the areas to be treated are small and the terrain is accessible to personnel and equipment. All herbicide applications are made only by trained, state-certified applicators. Whether the application is made by contractors or TVA crews, the sites to be treated should be selected and the application directed by the Customer Service Center Manager, Program Administrator, or the line foreman. Common techniques used in the ground application of herbicides are broadcast by hand, power blower, or other rotary equipment; by single bands or multiple bands using back pack or agricultural-type sprayers; spot grid using back pack or agricultural-type sprayers; cut stubble using back pack or agricultural-type sprayers; and basal or foliage applications using back pack sprayers. In all of the above applications, the applicator should periodically calibrate the application equipment to ensure that the herbicide is being applied at the

proper rate. Overapplication and underapplication are costly and ineffective. Also, when soil-active herbicides are being applied by ground crews, the herbicide should never be applied to areas where the roots of desirable or off right-of-way vegetation encroach or the material could be carried by storm runoff to an offsite location. Care should be taken to ensure that cumulative buildup of soil-active herbicide does not occur in substations or on the right-of-way.

It is important that accurate and up-to-date records be maintained concerning the plan for and the application of all herbicides. The location, herbicide applied, amount of herbicide applied, application method, and the size of the area treated should be recorded on a right-of-way maintenance report form TVA 7046. The responsible foreman should keep a copy of this record, and a copy should be sent to the Customer Service Center Manager, Program Administrator, and TSD.

TEST PLOTS

Test plots are used to evaluate new herbicide application methods and application rates for control, cost effectiveness, and environmental considerations. Often test plots are made in cooperation with a herbicide manufacturer supplying the material and/or application devices. All test plots should be coordinated with TSD so that all required documentation and approvals are obtained prior to the herbicide application. The documentation required before applying herbicides as a test plot are:

1. Herbicide label.
2. MSDS for herbicide and inert ingredients.
3. Plan and profile showing location of test plot.
4. Description of method of application.
5. Application rates to be used in test plot.
6. Environmental Decision Record (EDR)--this will be prepared by TSD.
7. Photos of site before application.
8. Photos of site at various time intervals after application.
9. Evaluation of test plot results.

The property owner should be informed that we are going to apply herbicides prior to their application.

MECHANICAL CLEARING

Mechanical clearing is the most widely used method of maintaining our rights-of-way. Therefore, good public relations between TVA and property owners are necessary if there is to be a successful right-of-way maintenance program. An attitude of friendliness, competence, and efficiency is necessary if TVA is to retain a good image. Our rights-of-way cross both private and public lands; therefore, when right-of-way reclearing work is planned, property owners and public officials should be notified well in advance of beginning work.

The two most commonly used tools for right-of-way maintenance are power saws and rotary cutting equipment (bushhogs). The stubble of brush and the stumps of trees should be cut as close as possible to the ground but normally should not exceed three inches in height except along stream banks, where stumps should be left approximately four feet high to help prevent soil erosion. Brush should never be cut and left in ditches, streams, roads, on fences, or in a manner that adversely impacts the property owner's access across his property. Good judgment should be exercised when determining whether or not brush and tree tops along the right-of-way should be cleared up. This decision is the responsibility of the Customer Service Center Manager. Trees that are abandoned to livestock, such as wild cherries when cut, should be removed from areas where livestock graze.

PROTECTION OF WETLANDS

On May 24, 1977, President Carter issued Executive Order No. 11990, which outlines certain procedures for the protection of wetlands. The term "wetlands" means those areas that are inundated by surface or groundwater with a frequency sufficient to support, and under normal circumstances does or would support, a prevalence of vegetative or aquatic life that required saturated or seasonally saturated soil conditions for growth and reproduction. Wetlands generally include swamps, marshes, bogs, and similar areas such as sloughs, potholes, wet meadows, river overflows, mud flats, and natural ponds.

When transmission line maintenance is performed, it should be planned and executed within the scope of the following guidelines.

1. In emergencies service will be restored as quickly as possible, and every effort will be made to avoid undue disturbance to the wetland. Flowing-stream banks are not to be disturbed, and precautions will be taken to prohibit erosion.

2. Prearranged maintenance (including pole changeouts) in wetlands will be scheduled when possible during the dry seasons with 90 days advanced notice to TSD.

3. In wetlands when water and muck are present, a Nodwell tracked carrier will be used to transport men, wire, crossarms, insulators, and other small hardware to the worksite.

4. When it is necessary to replace a pole, the Nodwell or a crawler tractor will be used to pull the pole to the site in the wetland.

5. Only herbicides specifically labeled for use in wetlands may be used in or at the edge of wetlands.

LIST OF RECOMMENDED HERBICIDES FOR RECLEARING

The following herbicides are recommended for use in vegetation control on transmission line rights-of-way, substations, and other TVA property. We will continue to evaluate new herbicides and will add new products to the list when appropriate. YOU MUST READ THE LABEL BEFORE USING THESE HERBICIDES.

Accord	Liquid mixed with water and surfactant. Registered for use in wetlands. Suggested for use on willows. Apply during active growth period at 4 or 5 quarts an acre. Available in 30-gallon drums and 2-1/2 gallon containers.
Arsenal	Liquid mixed with water and surfactant. Apply during active growth period at 8 to 16 ounces per acre. May be tank mixed with Accord.
Arsenal 0.5G	Ready-to-use granule form for control of Johnson grass and Bermuda grass. Apply at rates of 100 to 200 pounds an acre. Available in 50-pound bags at 2000 pounds a pallet.
Roundup	Liquid mixed with water. Used to control weeds. Postemergent, sprayed on actively growing plant foliage. Available in 30-gallon drums, 2-1/2 gallon and 1-gallon containers.
Spike 5G	Ready to use in granule form for control of weeds and brush. Application rates of 40-320 pounds an acre. Available in 40-pound plastic buckets at 1920 pounds a pallet.
Spike 40P	Ready to use in pellet form for brush and tree control. Apply at rates of 15 pounds an acre (6 pound active ingredient). Available in 20-pound bags at 1400 pounds a pallet.
Spike 80W	Mixed with water (never use dry). Used for brush and tree control. Application rate of 7.05 pounds an acre (6 pounds active ingredients). Available in pallet.
Spike Dry Flowable	Mixed with water (never use dry). Not available now, but may be some left in regions.
Sprakel S-5	Same as Spike 5G.
Topsite	Ready to use in granule form for bare ground control of weeds in substation yards, material yards, and pole degrassing. Apply at rates of 150 to 200 pounds an acre.

ATTACHMENT

Question 10

CHEMICAL REVIEW FORM

PART A: NEW CHEMICAL Y REVISE USE/QUANTITY (SQN HMC No.)
(BFN CTC No.)
(WBN CTC NO. 09.061)

PRODUCT INFORMATION:
Product: CLAM-TROL CT-1
Chemical Name:
CAS Number: TIIC Number:
Manufacturer: BETZ LABORATORIES, INC.
Address: 4636 SOMERTON RD.
City: TREVOSE State: PA Zip Code: 19053
Telephone: 800-877-1940
Shelf Life: 2 YRS Plant Code: WBN

USE INFORMATION:
Intended Use: CHEMICAL ADDITIVE
CONTROL MACROFOULING
Plant Location: SITEWIDE
Average Quantity Used: VARIOUS Frequency: AS NEEDED

KEY CONTACT:
Name: W.H. NALL SSN: 418-78-0922
Organization: CHEM Extension: 1992

PART B: REQUEST NUMBER: 0007 DATE RECEIVED: 06/25/92

CHEMICAL INFORMATION:
Required: Y
Total Halogens: *(1) ppm Leachable Fluoride: ppm
Leachable Chloride: ppm Total Sulfur: ppm
Total Organics: ppm Chelating Agents: % pH:
HAZARDOUS INGREDIENTS:

OPERATIONAL RESTRICTIONS:
Effects on plant systems, safety-related systems, structures and components materials, including austenitic stainless steel or nickel-base alloys, and plastics:
Specification Document: WBN SITE CHEMISTRY MANUAL.

RADIOLOGICAL WASTE RESTRICTIONS:

SAFETY REQUIREMENTS:
HMIG RATING: Health 3 Flammability 2 Reactivity 0 Other
USE CHEMICAL GOGGLES.
RUBBER PROTECTIVE CLOTHING.
ORGANIC VAPOR RESPIRATOR FILTER WHEN USED IN LOW VENTILATION AREAS.

ENVIRONMENTAL RESTRICTIONS:
Discharge covered by NPDES permit: Y Discharge Serial No.:102 **(2)
Hazardous Waste: Y EPA Hazardous Waste Code: D001&2

COMPOUND	PCT	REPORTABLE QUANTITY 40 CFR 302	EXT HAZ SUB	TPQ 40 CFR 355	REPORTING QUANTITY 40 CFR 370
ETHYLENE GLYCOL	30				10000 lbs
ALKYL DIMETHYL BENZYL AMMONIUM CL					10000 lbs
ISOPOROPYL ALCOHOL					10000 lbs
ETHYL ALCOHOL (ETHANOL)					10000 lbs
DODECYLGUANIDINE HYDROCHLORIDE					10000 lbs

Disposal Instructions: Solid Waste: Inert Landfill:
Special Waste: Hazardous Waste: Y

Spill Cleanup Requirements:
VENTILATE AREA. CONTAIN AND ABSORB ON ABSORBENT MATERIAL.
THE CONTAMINATED ABSORBENT SHOULD BE CONSIDERED A PESTICIDE.
DISPOSE IN AN APPROVED PESTICIDE LANDFILL. REMOVE IGNITION SOURCE.
FLUSH AREA WITH WATER.
NOTIFY ENVIRONMENTAL AND FIRE PROTECTION GROUPS.

PART C: APPROVAL: Y USE CODE: II APPROVED CHEMICAL NO: 09.061

Maximum Quantity:
Substitute:
Emergency Use Approval: Special Issue No.:
Restrictions: *(1) VENDOR TO FURNISH TEST RESULTS WITH SHIPMENT PER CHEMISTRY MANUAL.

**(2) PROVISIONAL STATE APPROVAL (STATE LETTER 9-30-92) FOR USE LIMITS CLAM-TROL CONC TO <0.2PPM IN DIF DISC (DSN 101).

Date: 02/02/93 Revision Number: 0

Chemical Summary

Product Name	BETZ ClamTrol CT-1
Description	Blend of dodecylguanide hydrochloride and alkydimethyl benzylammonium chloride
Function	Control macrofouling
% Actives	5% DGH/8% Quat
Density	8.51 lb/gal
Neat Product pH	5.3
Freeze Point	<-30°F
Average Dosage	15 ppm as product
Frequency	12-hour feed/every 90 days
Compatibility Problems	None
Toxicity Data	Daphnia Magna: LC_{50} = 0.47 mg/l
Effluent Concentration Allowed	Not in permit
Effluent Concentration Expected	<0.2 mg/l ~~<0.47 mg/l~~ *
Storage Requirements	Polyolefin/stainless steel
Shelf Life	2+ years
Storage Tank Size	280-gallon semi-bulk containers
Foaming	Some above ~20 ppm
EPA Approval	Yes-registered molluscicide
Effect on pH	None
Reportable Spill Quantity	Not applicable

*Effluent concentration will be minimized by feeding only when CCW is in operation

BETZ LABORATORIES,INC.
4636 SOMERTON ROAD, TREVOSE, PA. 19053
BETZ MATERIAL SAFETY DATA SHEET
EMERGENCY TELEPHONE (HEALTH/ACCIDENT) 800-877-1940

PRODUCT : CLAM-TROL CT-1
EFFECTIVE DATE 02-16-91
PRINTED: 1-Mar-1991
REVISIONS TO SECTIONS: -;EDIT:APPENDIX

PRODUCT APPLICATION : WATER-BASED MICROBIAL CONTROL AGENT.

-----SECTION 1----------HAZARDOUS INGREDIENTS----------

INFORMATION ON PHYSICAL HAZARDS, HEALTH HAZARDS, PEL'S AND TLV'S FOR SPECIFIC PRODUCT INGREDIENTS AS REQUIRED BY THE OSHA HAZARD COMMUNICATIONS STANDARD IS LISTED. REFER TO SECTION 4 (PAGE 2) FOR OUR ASSESSMENT OF THE POTENTIAL ACUTE AND CHRONIC HAZARDS OF THIS FORMULATION.

ETHYLENE GLYCOL***CAS#107-21-1;LIVER, KIDNEY AND BLOOD TOXIN;CNS DEPRESSANT;ANIMAL TERATOGEN(HIGH ORAL DOSES);PEL/TLV:50PPM-C.

ALKYL DIMETHYL BENZYL AMMONIUM CHLORIDE***CAS#68424-85-1;CORROSIVE(EYES); PEL:NONE;TLV:NONE.

ISOPROPYL ALCOHOL(IPA)***CAS#67-63-0;FLAMMABLE LIQUID;CHRONIC OVEREXPOSURE MAY CAUSE LIVER AND KIDNEY TOXICITY;PEL/TLV:400PPM (500PPM-STEL).

DODECYLGUANIDINE HYDROCHLORIDE***(DGH);CAS#13590-97-1;CORROSIVE;PEL:NONE; TLV:NONE.

ETHYL ALCOHOL(ETHANOL)***CAS#64-17-5;FLAMMABLE;EYE IRRITANT;MAY CAUSE DEFATTING DERMATITIS,DIZZINESS AND HEADACHE;PEL/TLV:1000PPM.

-----SECTION 2----------TYPICAL PHYSICAL DATA----------

PH: AS IS	(APPROX.) 5.3	ODOR: MILD	
FL.PT.(DEG.F): 116	SETA(CC)	SP.GR.(70F)OR DENSITY: 1.022	
VAPOR PRESSURE(mmHG): 23		VAPOR DENSITY(AIR=1): >1	
VISC cps70F: 23		%SOLUBILITY(WATER): 100	
EVAP.RATE: <1	ETHER=1	APPEARANCE: COLORLESS	
PHYSICAL STATE: LIQUID		FREEZE POINT(DEG.F): <-30	

-----SECTION 3----------REACTIVITY DATA----------

STABLE.MAY REACT WITH STRONG OXIDIZERS.DO NOT CONTAMINATE.BETZ TANK CLEAN-OUT CATEGORY 'B'

THERMAL DECOMPOSITION (DESTRUCTIVE FIRES) YIELDS ELEMENTAL OXIDES.

PRODUCT: CLAM-TROL CT-1

-----SECTION 4----------HEALTH HAZARD EFFECTS----------

ACUTE SKIN EFFECTS *** PRIMARY ROUTE OF EXPOSURE
ORROSIVE TO SKIN.POTENTIAL SKIN SENSITIZER

ACUTE EYE EFFECTS ***
CORROSIVE TO THE EYES

ACUTE RESPIRATORY EFFECTS *** PRIMARY ROUTE OF EXPOSURE
VAPORS,GASES,MISTS AND/OR AEROSOLS CAUSE IRRITATION TO UPPER RESPIRATORY TRACT

CHRONIC EFFECTS OF OVEREXPOSURE***
PROLONGED OR REPEATED OVEREXPOSURES MAY CAUSE: TISSUE NECROSIS;BLOOD CELL DAMAGE OR IMPAIR BLOOD CELL FUNCTION; REPRODUCTIVE SYSTEM TOXICITY; SKIN SENSITIZATION.

MEDICAL CONDITIONS AGGRAVATED ***
NOT KNOWN

SYMPTOMS OF EXPOSURE ***
INHALATION OF VAPORS/MISTS/AEROSOLS MAY CAUSE EYE,NOSE,THROAT AND LUNG IRRITATION;SKIN CONTACT MAY CAUSE SEVERE IRRITATION OR BURNS.

PRECAUTIONARY STATEMENT BASED ON TESTING RESULTS ***
MAY BE TOXIC IF ORALLY INGESTED.

-----SECTION 5----------FIRST AID INSTRUCTIONS----------

SKIN CONTACT***
REMOVE CLOTHING.WASH AREA WITH LARGE AMOUNTS OF SOAP SOLUTION OR WATER FOR 15 MIN.IMMEDIATELY CONTACT PHYSICIAN

EYE CONTACT***
IMMEDIATELY FLUSH EYES WITH WATER FOR 15 MINUTES.IMMEDIATELY CONTACT A PHYSICIAN FOR ADDITIONAL TREATMENT

INHALATION EXPOSURE***
REMOVE VICTIM FROM CONTAMINATED AREA.APPLY NECESSARY FIRST AID TREATMENT.IMMEDIATELY CONTACT A PHYSICIAN.

INGESTION***
DO NOT FEED ANYTHING BY MOUTH TO AN UNCONSCIOUS OR CONVULSIVE VICTIM
DO NOT INDUCE VOMITING.IMMED.CONTACT PHYSICIAN.DILUTE CONTENTS OF STOMACH USING 3-4 GLASSES MILK OR WATER

-----SECTION 6----------SPILL,DISPOSAL AND FIRE INSTRUCTIONS---------

SPILL INSTRUCTIONS***
VENTILATE AREA,USE SPECIFIED PROTECTIVE EQUIPMENT.CONTAIN AND ABSORB ON ABSORBENT MATERIAL.PLACE IN WASTE DISPOSAL CONTAINER.THE CONTAMINATED ABSORBENT SHOULD BE CONSIDERED A PESTICIDE AND DISPOSED OF IN AN APPROVED PESTICIDE LANDFILL.SEE PRODUCT LABEL STORAGE AND DISPOSAL INSTRUCTIONS.
REMOVE IGNITION SOURCES.FLUSH AREA WITH WATER.SPREAD SAND/GRIT.

DISPOSAL INSTRUCTIONS***
WATER CONTAMINATED WITH THIS PRODUCT MAY BE SENT TO A SANITARY SEWER TREATMENT FACILITY,IN ACCORDANCE WITH ANY LOCAL AGREEMENT,A PERMITTED WASTE TREATMENT FACILITY OR DISCHARGED UNDER A NPDES PERMIT
PRODUCT(AS IS)-
DISPOSE OF IN APPROVED PESTICIDE FACILITY OR ACCORDING TO LABEL INSTRUCTIONS

FIRE EXTINGUISHING INSTRUCTIONS***
FIREFIGHTERS SHOULD WEAR POSITIVE PRESSURE SELF-CONTAINED BREATHING APPARATUS(FULL FACE-PIECE TYPE).PROPER FIRE EXTINGUISHING MEDIA: DRY CHEMICAL,CARBON DIOXIDE,FOAM OR WATER

PRODUCT: CLAM-TROL CT-1

-----SECTION 7----------SPECIAL PROTECTIVE EQUIPMENT----------

USE PROTECTIVE EQUIPMENT IN ACCORDANCE WITH 29CFR SECTION 1910.132-134. USE
IRATORS WITHIN USE LIMITATIONS OR ELSE USE SUPPLIED AIR RESPIRATORS.
TILATION PROTECTION***
ADEQUATE VENTILATION TO MAINTAIN AIR CONTAMINANTS BELOW EXPOSURE LIMITS
RECOMMENDED RESPIRATORY PROTECTION***
IF VENTILATION IS INADEQUATE OR SIGNIFICANT PRODUCT EXPOSURE IS LIKELY,
USE A RESPIRATOR WITH ORGANIC VAPOR CARTRIDGE & DUST/MIST PREFILTER
RECOMMENDED SKIN PROTECTION***
GAUNTLET-TYPE RUBBER GLOVES,CHEMICAL RESISTANT APRON
WASH OFF AFTER EACH USE.REPLACE AS NECESSARY
RECOMMENDED EYE PROTECTION***
SPLASH PROOF CHEMICAL GOGGLES.FACE SHIELD

-----SECTION 8----------STORAGE AND HANDLING PRECAUTIONS----------

STORAGE INSTRUCTIONS***
KEEP DRUMS & PAILS CLOSED WHEN NOT IN USE.
STORE IN COOL VENTILATED LOCATION.STORE AWAY FROM OXIDIZERS
HANDLING INSTRUCTIONS***
COMBUSTIBLE. DO NOT USE AROUND SPARKS OR FLAMES. BOND CONTAINERS
DURING FILLING OR DISCHARGE WHEN PERFORMED AT TEMPERATURES AT OR
ABOVE THE PRODUCT FLASH POINT.

****

THIS MSDS WAS WRITTEN TO COMPLY WITH THE OSHA HAZARD COMMUNICATION STANDARD

****

APPENDIX: REGULATORY INFORMATION

THE CONTENT OF THIS APPENDIX REPRESENTS INFORMATION KNOWN TO BETZ ON THE
EFFECTIVE DATE OF THIS MSDS. THIS INFORMATION IS BELIEVED TO BE ACCURATE.
ANY CHANGES IN REGULATIONS WILL RESULT IN UPDATED VERSIONS OF THIS DOCUMENT.

TSCA: THIS IS AN EPA REGISTERED BIOCIDE AND IS EXEMPT FROM TSCA INVENTORY
REQUIREMENTS
...FIFRA(40CFR):EPA REG.NO. 3876- 145
...REPORTABLE QUANTITY(RQ) FOR UNDILUTED PRODUCT:
NOT APPLICABLE
...RCRA: IF THIS PRODUCT IS DISCARDED AS A WASTE,THE RCRA HAZARDOUS WASTE
IDENTIFICATION NUMBER IS: D001=IGNITABLE;D002=CORROSIVE(SKIN)
...DOT HAZARD/UN#/ER GUIDE# IS: CORROSIVE TO SKIN.COMBUSTIBLE UN1760/#60
...CALIFORNIA SAFE DRINKING WATER ACT (PROPOSITION 65) MATERIALS: NONE
...SARA SECTION 302 CHEMICALS: NONE
...SARA SECTION 313 CHEMICALS: ETHYLENE GLYCOL(107-21-1) , 21.0-30.0% ;
...SARA SECTION 312 HAZARD CLASS: IMMEDIATE(ACUTE),DELAYED(CHRONIC) AND FIRE
...MICHIGAN CRITICAL MATERIALS: NONE
NFPA/HMIS : HEALTH - 3 ; FIRE - 2 ; REACTIVITY - 0 ; SPECIAL - CORR ; PE - D

Betz Industrial

CLAMTROL CT-1

ANALYTICAL PROCEDURES

CLAM-TROL CT-1
METHYL ORANGE METHOD

APPARATUS REQUIRED

	Code
Beaker, glass, 50 mL (x2)	---
Cylinder, graduated, 25 mL	2622
Funnel rack, separatory	936
Funnel, separatory, w/teflon stopcock, 250 mL (x2)	---
Glass rod	114
Optical cell, (x2)	---
Spectrophotometer	---

GENERAL APPARATUS *

	Code
Cylinder, graduated, 100 mL	121
Cylinder, graduated, 250 mL	917
Flask, volumetric, 1 liter, glass (x4)	935
Pipette, glass, volumetric, 1 mL	866
Pipette, glass, 1 mL, graduated	140
Pipette, glass, volumetric, 3 mL	---
Pipette, glass, volumetric, 5 mL	124
Pipette, glass, volumetric, 10 mL	123
Pipette, glass, volumetric, 15 mL	861
Pipette, glass, volumetric, 20 mL	---
Pipette, glass, volumetric, 25 mL	117
Pipette, glass, volumetric, 30 mL	---

* The general apparatus required for the test is determined by the specific test procedure used.

CHEMICALS REQUIRED

	Code
1,2-Dichloroethane (reagent grade or equivalent)	----
CT-1 Buffer Reagent	1591
Methanol (reagent grade or equivalent)	----
Drying Reagent w/plastic dipper	1271

Note: Apparatus and chemicals not available through Betz Lab Supply should be obtained through a local supplier.

DISCUSSION OF THE METHOD

In this test procedure, methyl orange complexes with the active ingredients in Clam-Trol CT-1. This complex is extracted into 1,2-dichloroethane. The organic layer containing the complex is separate from the aqueous layer and dried with anhydrous sodium sulfate. The color intensity of the 1,2-dichloroethane layer is then measured at 415 nm.

This method must be customized to each specific application. This is done by varying the volumes of sample, CT-1 Buffer Reagent and 1,2-dichloroethane used in the procedure. Table 1 lists several combinations of reagents that can be used to obtain three different test ranges. When optimizing the procedure, if a higher absorbance is needed, the volume of sample should be increased or the volume of 1,2-dichloroethane should be decreased. When increasing the sample volume it may be necessary to increase the volume of CT-1 Buffer Reagent used. For sample volumes of less than 150 mL use 10 mL of the CT-1 Buffer Reagent; for volumes between 150 and 300 mL use 15 mL of CT-1 Buffer Reagent. When determining the amount of 1,2-dichloroethane to use it is necessary to make sure that the volume used is large enough to have sufficient 1,2-dichloroethane to leave a small plug of solvent in the separatory funnel when removing the bottom layer of solvent while having enough solvent to fill the optical cell properly.

GENERAL PROCEDURE FOR TEST

Use a well ventilated or hooded area to run the test. Always use a safety bulb when pipetting liquids.

1. Transfer an aliquot of the water sample to a separatory funnel (the sample). Transfer the same volume of distilled (or deionized) water to a second separatory funnel (the blank). It is only necessary to run the blank once for each set of samples tested (see notes 1 and 2).

Table 1: Suggested Volumes for Various Ranges of CT-1

Range mg/L CT-1	volume (mL) CT-1 Buffer	volume (mL) dichloroethane	volume (mL) sample	optical cell size
0.2 - 3.0	15	10	250	1.0 cm *
1.0 -25.0	10	30	50	2.5 cm **
0.2 - 1.0	10	15	100	5.0 cm ***

* The 1.0 cm cell can be used with Hach spectrophotometers utilizing a 1 cm cell adapter.

** The 2.5 cm cell is the standard Hach 1 inch cell (Betz code 2601) that can be used with Hach spectrophotometers.

*** 5 cm cells are not available for the Hach photometers. Many laboratory spectrophotometers require an adapter to accommodate 5 cm cells. Check with the instrument manufacturer.

2. Add the CT-1 Buffer Reagent to both the sample and the blank (see note 6).

3. Using a pipette, add the 1,2-dichloroethane to both separatory funnels.

4. Insert the stoppers in each of the separatory funnels, invert and briefly open the stopcock to vent the funnels (see notes 3 and 4). When venting the funnels point the tip of the funnel away from yourself and others.

5. Shake the funnels moderately for 30 seconds, vent the funnels, then allow to stand for 10 minutes (but no longer than 15 minutes)

6. Collect the lower layer from each funnel (the 1,2-dichloroethane) in 50 mL beakers. It is most convenient to allow a small amount of the 1,2-dichloroethane (~1-2 mL) to remain in the funnel. This prevents any significant removal of water from the separatory funnel when the 1,2-dichloroethane is being removed.

7. Using the plastic dipper, add 2 scoops of Drying Reagent to each beaker and stir with a glass rod for 10 seconds (but no longer than 20 seconds).

8. Wait approximately 1 to 2 minutes (but not more than 5 minutes) then carefully decant the extract off of the drying reagent into an optical cell.

9. Set the spectrophotometer at 415 nm and zero with 1,2-dichloroethane. Measure and record the absorbance of the blank and the sample.

10. The sample absorbance minus the blank absorbance is used to determine the concentration of CT-1 in the sample. From a prepared calibration curve, determine the CT-1 concentration in the sample (see Calibration Preparation).

11. Clean the cells after each measurement (see note 5).

CALIBRATION PREPARATION

1. Prepare a 1000 mg/L CT-1 stock solution by accurately weighing out 1.00 gram of CT-1 into 1 liter of distilled or deionized water.

2. Pipet designated volumes of the stock solution into 1 liter volumetric flasks. These are the standard solution to be used in preparing a calibration curve. Use Table 2 to determine the appropriate dilutions to make of the stock solution for each specific application.

Table 2: Dilutions for Calibration Curve Preparation (based on final solution volume of 1 liter)

Conc. mg/L CT-1 desired	mL CT-1 Stock solution added to make 1 liter
0.2	0.2
0.4	0.4
0.6	0.6
0.8	0.8
1.0	1.0
5.0	5.0
10.0	10.0
15.0	15.0
20.0	20.0
25.0	25.0

3. Follow the procedure listed (utilizing the specific solution volumes that have been determined for the application) and prepare a calibration curve. Determine the absorbance of a blank solution using distilled or deionized water. This blank can be subtracted from the sample absorbance or used to zero the photometer so that the calibration curve goes through the origin. The calibration curve should be linear over the indicated ranges.

NOTES

1. For maximum accuracy the calibration curve should be checked by every operator using the test and should be verified a minimum of twice per month using a freshly prepared CT-1 standard.

2. A blank measurement must be recorded for each set of samples. The blank reading may vary slightly, however the absolute difference between the sample and the blank remains relatively constant.

3. A slight emulsion may form when using natural water samples. Correct for this by using a variation in step 5 of the procedure. Shake the funnel for 30 seconds then allow to stand for 5 minutes. Gently invert the funnel once then allow the funnel to stand for 5 minutes (don't forget to vent the funnel).

4. It is important to vent the separatory funnel both before and after shaking it. Otherwise, a pressure will build up in the funnel that can cause the stopper to be forced out of the top of the funnel.

5. It is imperative that the sample cells are kept clean during the running of the test. It is recommended that the cells are cleaned after each measurement by the following procedure:

   a) Rinse the cell three times with distilled or deionized water.
   b) Rinse the cell three times with methanol.

c) Finally rinse the cell three times with 1,2-dichloroethane to remove any methanol from the cell.

6. Chlorine causes a negative interference in the test. This can be eliminated by adding 0.1 N sodium thiosulfate (code 235) to the water sample before running the test. The amount to be added must be determined based on the concentration of chlorine in the syste For a 100 mL water sample containing 0.3 mg/L chlorine, 10 drops of 0.1 N sodium thiosulfate will remove the interference.

7. This method is based upon L. K. Wang and D. F. Langly, Ind. Eng. Chem., Prod. Res. Dev., (1975) Vol. 14, No. 3, 210-212

CHEMICAL REVIEW FORM

PART A: NEW CHEMICAL Y REVISE USE/QUANTITY (SQN HMC No.)
(BFN CTC No.)

PRODUCT INFORMATION:
Product: BETZ COPPERTROL CU-1
Chemical Name:
CAS Number: TIIC Number:
Manufacturer: BETZ LABORATORIES,INC.
Address: 4636 SOMERTON ROAD
City: TREVOSE State: PA Zip Code: 19053
Telephone: 1-800-877-1940
Shelf Life: 2-YEARS Plant Code: WBN

USE INFORMATION:
Intended Use: CHEMICAL ADDITIVES
Plant Location: SITEWIDE
Average Quantity Used: Frequency:

KEY CONTACT:
Name: W.H.NALL SSN: 418-78-0922
Organization: CHEMISTRY Extension: 1992

PART B: REQUEST NUMBER: 0006 DATE RECEIVED: 06/25/92

CHEMICAL INFORMATION:
Required: Y
Total Halogens: ppm Leachable Fluoride: ppm
Leachable Chloride: ppm Total Sulfur: ppm
Total Organics: ppm Chelating Agents: % pH:
HAZARDOUS INGREDIENTS:

OPERATIONAL RESTRICTIONS:
Effects on plant systems, safety-related systems, structures and components materials, including austenitic stainless steel or nickel-base alloys, and plastics:
Specification Document: NEW ITEM TO BE INCLUDED IN WBN SITE *(1)

RADIOLOGICAL WASTE RESTRICTIONS:

SAFETY REQUIREMENTS:
HMIG RATING: Health 3 Flammability 1 Reactivity 0 Other
EYE AND SKIN PROTECTION (RUBBER GLOVES).
RESPIRATORY PROTECTION WHEN USED IN LOW VENTALATION ENVIRONMENTS.

ENVIRONMENTAL RESTRICTIONS:
Discharge covered by NPDES permit: Y Discharge Serial No.:WBN 101-103,108,107
Hazardous Waste: Y EPA Hazardous Waste Code: D002

COMPOUND	PCT	REPORTABLE QUANTITY 40 CFR 302	EXT HAZ SUB	TPQ 40 CFR 355	REPORTING QUANTITY 40 CFR 370
SODIUM HYDROXIDE		1000 lbs			10000 lbs
BUTYL BENZOTRIAZOLE					

Disposal Instructions: Solid Waste: Inert Landfill:
Special Waste: Hazardous Waste: Y

Spill Cleanup Requirements:
NOTIFY ENVIRONMENTAL GROUP.
ABSORB OR ABSORBENT MATERIAL.
PLACE IN WASTE DISPOSE CONTAINER.
MAY BE DISCHARGED UNDER A NPDES PERMIT.

PART C: APPROVAL: Y USE CODE: II APPROVED CHEMICAL NO: 09.054

Maximum Quantity:
Substitute:
Emergency Use Approval: Special Issue No.:
Restrictions: VENDOR TO FINISH TEST RESULTS W/SHIPMENT AS APPLICABLE.
*(1) CHEMISTRY MANUAL.
ONLY SMALL QUANITY IS AUTHORIZED TO BE DISCHARGED TO DSN 101 -103.
Date: 07/14/92 Revision Number: 0

Chemical Summary

Product Name	BETZ CopperTrol Cu-1
Description	Azole copper corrosion inhibitor
Function	Reduce corrosion of copper alloys
% Actives	10%
Density	9.86 lb/gal
Neat Product pH	13.5
Freeze Point	-4°F
Average Dosage	50 ppm product
Frequency	10 minutes/every 2-3 weeks
Compatibility Problems	None
Toxicity Data	0% mortality at 112.5 mg/l
Effluent Concentration Allowed	Not in permit
Effluent Concentration Expected	< 5 ppm active
Storage Requirements	Polyolefin tank, lined drums,
Shelf Life	2+ years
Storage Tank Size	55-gallon drums
Foaming	Not at use concentrations
EPA Approval	Yes
Effect on pH	None
Reportable Spill Quantity	740 gallons

BETZ LABORATORIES,INC.
4636 SOMERTON ROAD, TREVOSE, PA. 19053
BETZ MATERIAL SAFETY DATA SHEET
EMERGENCY TELEPHONE (HEALTH/ACCIDENT) 800-877-1940

PRODUCT : COPPER-TROL CU-1

EFFECTIVE DATE 02-16-91
PRINTED: 1-Mar-1991

REVISIONS TO SECTIONS: -;EDIT:APPENDIX.

PRODUCT APPLICATION : WATER-BASED CORROSION INHIBITOR.

-----SECTION 1----------HAZARDOUS INGREDIENTS----------

INFORMATION ON PHYSICAL HAZARDS, HEALTH HAZARDS, PEL'S AND TLV'S FOR SPECIFIC PRODUCT INGREDIENTS AS REQUIRED BY THE OSHA HAZARD COMMUNICATIONS STANDARD IS LISTED. REFER TO SECTION 4 (PAGE 2) FOR OUR ASSESSMENT OF THE POTENTIAL ACUTE AND CHRONIC HAZARDS OF THIS FORMULATION.

SODIUM HYDROXIDE***(CAUSTIC SODA)***CAS#1310-73-2;CORROSIVE;TOXIC IF ORALLY INGESTED;PEL:2.0MG/M3;TLV:2.0MG/M3(CEILING).

BUTYL BENZOTRIAZOLE,SODIUM SALT***CAS#18685-34-0;POTENTIAL SKIN SENSITIZER; CORROSIVE TO SKIN AND EYES;PEL:NONE;TLV:NONE; NOTE-NOT ON ANY STATE RTK LIST.

-----SECTION 2----------TYPICAL PHYSICAL DATA----------

PH: AS IS (APPROX.) 13.5	ODOR: MILD
FL.PT.(DEG.F): >200 P-M(CC)	SP.GR.(70F)OR DENSITY: 1.184
VAPOR PRESSURE(mmHG): 18	VAPOR DENSITY(AIR=1): <1
VISC cps70F: 37	%SOLUBILITY(WATER): 100
EVAP.RATE: <1 ETHER=1	APPEARANCE: BROWN-BLACK
PHYSICAL STATE: LIQUID	FREEZE POINT(DEG.F): -4

-----SECTION 3----------REACTIVITY DATA----------

STABLE.MAY REACT WITH ACIDS.DO NOT CONTAMINATE. BETZ TANK CLEAN-OUT CATEGORY 'C'

THERMAL DECOMPOSITION (DESTRUCTIVE FIRES) YIELDS ELEMENTAL OXIDES.

PRODUCT: COPPER-TROL CU-1

-----SECTION 4----------HEALTH HAZARD EFFECTS----------

ACUTE SKIN EFFECTS *** PRIMARY ROUTE OF EXPOSURE
CORROSIVE TO SKIN.SKIN SENSITIZER

ACUTE EYE EFFECTS ***
CORROSIVE TO THE EYES

ACUTE RESPIRATORY EFFECTS ***
MISTS/AEROSOLS CAUSE IRRITATION TO UPPER RESPIRATORY TRACT

CHRONIC EFFECTS OF OVEREXPOSURE***
PROLONGED OR REPEATED CONTACT MAY CAUSE TISSUE NECROSIS,DERMATITIS AND/OR SKIN SENSITIZATION.

MEDICAL CONDITIONS AGGRAVATED ***
NOT KNOWN

SYMPTOMS OF EXPOSURE ***
CAUSES SEVERE IRRITATION,BURNS OR TISSUE ULCERATION WITH SUBSEQUENT SCARRING.

PRECAUTIONARY STATEMENT BASED ON TESTING RESULTS ***
MAY BE TOXIC IF ORALLY INGESTED.

-----SECTION 5----------FIRST AID INSTRUCTIONS----------

SKIN CONTACT***
REMOVE CLOTHING.WASH AREA WITH LARGE AMOUNTS OF SOAP SOLUTION OR WATER FOR 15 MIN.IMMEDIATELY CONTACT PHYSICIAN

EYE CONTACT***
IMMEDIATELY FLUSH EYES WITH WATER FOR 15 MINUTES.IMMEDIATELY CONTACT A PHYSICIAN FOR ADDITIONAL TREATMENT

INHALATION EXPOSURE***
REMOVE VICTIM FROM CONTAMINATED AREA.APPLY NECESSARY FIRST AID TREATMENT.IMMEDIATELY CONTACT A PHYSICIAN.

INGESTION***
DO NOT FEED ANYTHING BY MOUTH TO AN UNCONSCIOUS OR CONVULSIVE VICTIM
DO NOT INDUCE VOMITING.IMMED.CONTACT PHYSICIAN.DILUTE CONTENTS OF STOMACH USING 3-4 GLASSES MILK OR WATER

-----SECTION 6----------SPILL,DISPOSAL AND FIRE INSTRUCTIONS---------

SPILL INSTRUCTIONS***
VENTILATE AREA,USE SPECIFIED PROTECTIVE EQUIPMENT.CONTAIN AND ABSORB ON ABSORBENT MATERIAL.PLACE IN WASTE DISPOSAL CONTAINER. THE WASTE CHARACTERISTICS OF THE ABSORBED MATERIAL,OR ANY CONTAMINATED SOIL, SHOULD BE DETERMINED IN ACCORDANCE WITH RCRA REGULATIONS.
FLUSH AREA WITH WATER. WET AREA MAY BE SLIPPERY. SPREAD SAND/GRIT.

DISPOSAL INSTRUCTIONS***
WATER CONTAMINATED WITH THIS PRODUCT MAY BE SENT TO A SANITARY SEWER TREATMENT FACILITY,IN ACCORDANCE WITH ANY LOCAL AGREEMENT,A PERMITTED WASTE TREATMENT FACILITY OR DISCHARGED UNDER A NPDES PERMIT
PRODUCT(AS IS)-
INCINERATE OR BURY IN APPROVED LANDFILL

FIRE EXTINGUISHING INSTRUCTIONS***
FIREFIGHTERS SHOULD WEAR POSITIVE PRESSURE SELF-CONTAINED BREATHING APPARATUS(FULL FACE-PIECE TYPE).PROPER FIRE EXTINGUISHING MEDIA; DRY CHEMICAL,CARBON DIOXIDE,FOAM OR WATER

PRODUCT: COPPER-TROL CU-1

-----SECTION 7----------SPECIAL PROTECTIVE EQUIPMENT----------

'E PROTECTIVE EQUIPMENT IN ACCORDANCE WITH 29CFR SECTION 1910.132-134. USE
RESPIRATORS WITHIN USE LIMITATIONS OR ELSE USE SUPPLIED AIR RESPIRATORS.
VE .ILATION PROTECTION***
ADEQUATE VENTILATION TO MAINTAIN AIR CONTAMINANTS BELOW EXPOSURE LIMITS
RECOMMENDED RESPIRATORY PROTECTION***
IF VENTILATION IS INADEQUATE OR SIGNIFICANT PRODUCT EXPOSURE IS LIKELY,
USE A RESPIRATOR WITH DUST/MIST FILTERS.
RECOMMENDED SKIN PROTECTION***
GAUNTLET-TYPE RUBBER GLOVES,CHEMICAL RESISTANT APRON
WASH OFF AFTER EACH USE.REPLACE AS NECESSARY
RECOMMENDED EYE PROTECTION***
SPLASH PROOF CHEMICAL GOGGLES.FACE SHIELD

-----SECTION 8----------STORAGE AND HANDLING PRECAUTIONS----------

STORAGE INSTRUCTIONS***
.KEEP DRUMS & PAILS CLOSED WHEN NOT IN USE.
DO NOT FREEZE.IF FROZEN,THAW AND MIX COMPLETELY PRIOR TO USE
HANDLING INSTRUCTIONS***
ALKALINE.CORROSIVE(SKIN/EYES).DO NOT MIX WITH ACIDIC MATERIAL,

****

THIS MSDS WAS WRITTEN TO COMPLY WITH THE OSHA HAZARD COMMUNICATION STANDARD

****

APPENDIX: REGULATORY INFORMATION

THE CONTENT OF THIS APPENDIX REPRESENTS INFORMATION KNOWN TO BETZ ON THE EFFECTIVE DATE OF THIS MSDS. THIS INFORMATION IS BELIEVED TO BE ACCURATE, ANY CHANGES IN REGULATIONS WILL RESULT IN UPDATED VERSIONS OF THIS DOCUMENT,

...TSCA: ALL COMPONENTS OF THIS PRODUCT ARE LISTED ON THE TSCA INVENTORY
...REPORTABLE QUANTITY(RQ) FOR UNDILUTED PRODUCT:
GALLONS DUE TO SODIUM HYDROXIDE
...RCRA: IF THIS PRODUCT IS DISCARDED AS A WASTE,THE RCRA HAZARDOUS WASTE IDENTIFICATION NUMBER IS: D002=CORROSIVE(SKIN,PH)
...DOT HAZARD/UN#/ER GUIDE# IS: CORROSIVE TO SKIN UN1824/#60
...CALIFORNIA SAFE DRINKING WATER ACT (PROPOSITION 65) MATERIALS; NONE
...SARA SECTION 302 CHEMICALS: NONE
...SARA SECTION 313 CHEMICALS: NONE
...SARA SECTION 312 HAZARD CLASS: IMMEDIATE(ACUTE) AND DELAYED(CHRONIC)
...MICHIGAN CRITICAL MATERIALS: NONE
NFPA/HMIS : HEALTH - 3 ; FIRE - 1 ; REACTIVITY - 0 ; SPECIAL - CORR ; PE - D

Betz Industrial
The Water Management Division of Betz Laboratories, Inc

product facts

BETZ® COPPER-TROL™ Cu-1 INHIBITOR

- Inhibits corrosion of copper and copper alloys
- Provides long-lasting protection
- Applicable to once-through and recirculating cooling water systems

DESCRIPTION AND USE

Betz Copper-Trol Cu-1 is a cooling water corrosion inhibitor specifically designed to establish a long-lasting protective film on copper and copper alloys. The purchase of this product from Betz provides a license under U.S. Patent 4 144,950.

TYPICAL APPLICATIONS

Betz Copper-Trol Cu-1 is designed for once-through and recirculating cooling water systems. It is shot fed to establish a film that protects the metal surface for two to six weeks. This product also indirectly inhibits the corrosion of mild steel when that corrosion is due to a galvanic cell between the mild steel and products of copper corrosion.

TREATMENT AND FEEDING REQUIREMENTS

Dosage. Treatment levels of Betz Copper-Trol Cu-1 depend on many factors specific to each location. Your Betz Industrial representative will establish specific guidelines for your system. The normal dosage is 50 ppm, based on recirculation rate, applied every two to six weeks, depending on film persistence. Betz Copper-Trol Cu-1 should be shot fed to a circulating system or fed continuously for 10 to 15 minutes in a once-through system.

Feed point. Betz Copper-Trol Cu-1 should be fed to a point in the system where conditions (turbulence, flow patterns, etc.) ensure good mixing of the product in the water to be treated.

Dilution. Betz Copper-Trol Cu-1 may be fed directly from the shipping container or diluted with good quality water to a convenient feeding strength.

Feed equipment. Mild steel, stainless steel, Polypropylene, Polyethylene, PVC, Teflon, and Hypalon tanks, pumps, and piping are compatible with this product.

Chlorine. This product is degraded by chlorine. The level of chlorination directly affects the persistence of the protective film. It should not be fed concurrently with chlorine. Between applications free chlorine residuals should not routinely exceed 0.4 ppm.

GENERAL PROPERTIES

Appearance	brown-black liquid
Density at 70 °F (21 °C)	9.86 lb/gal (1.18 kg/L)
Flash Point (closed cup)	> 200 °F (93 °C)
Freeze Point (ASTM))	−4 °F (−20 °C
pH (undiluted)	13.5
Specific Gravity at 70 °F (21 °C)	1.184
Viscosity at 70 °F (21 °C)	37 cP

STORAGE

Protect Copper-Trol Cu-1 from freezing. If it freezes during shipping or storage, mix this product to ensure homogeneity.

SAFETY PRECAUTIONS

A Material Safety Data Sheet containing detailed information relative to this product is available upon request.

PACKAGING INFORMATION

Betz Copper-Trol Cu-1 is blended as a liquid and is available in 55-gal (208-L) bung-type, nonreturnable drums. Approximate net weight is 520 lb (236 kg) per drum. In addition, Betz Copper-Trol Cu-1 is available under the Betz Point Of Feed® and Betz Semi-Bulk Control™ Service Programs for contracted quantities in certain geographic areas.

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BETZ
TREVOSE, PENNSYLVANIA 19047

ANALYTICAL TEST METHOD

REF. NO. ATM-055.2.1

HPLC DETERMINATION OF TOLYLTRIAZOLE (TTA) IN WATER

COMPOUND NAME: Tolyltriazole (TTA)

RANGE: 500-5 mg/L (ppm) as Betz 562C
100-1 mg/L as TTA

TECHNIQUE: Reverse-phase liquid chromatography with UV detection.

PRINCIPLE: Betz 562C is separated from its water matrix using a 10 um C-18 reverse-phase column and its absorbance measured via variable wavelength detector at 260 nm.

REAGENTS: TTA - Cobratech TT-100 or Betz 562C.
Methanol HPLC grade, Burdick & Jackson recommended.
Water, HPLC grade, Burdick & Jackson recommended.
Potassium dihydrogen phosphate, reagent grade.
Phosphoric acid, reagent grade, for buffer pH adjustment.
Potassium Hydroxide, reagent grade, for buffer pH adjustment.

APPARATUS: High pressure liquid chromatograph, Research grade with C-18 reverse-phase column, Whatman ODS-3 recommended. UV detector usable at 260 nm (254 nm fixed wavelength is acceptable).

Injector, 20 ul fixed loop valve.

PROCEDURE:

1. Mobile Phase Preparation: Dissolve 13.6g KH_2PO_4 into 1L deionized water to prepare 0.1 M KH_2PO_4 stock solution. Dilute 100 mL of this stock solution to 1L (0.01M KH_2PO_4) and adjust pH to 7.0 ± .1 with phosphoric acid or potassium hydroxide.

   Identify as solvent "A".

   Solvent "B" is 100% Methanol. Premix solvents "A" and "B" to a volume/volume mixture of 65% "A" and 35% "B" via pump proportioning valves or external isocratic mix. Degass mixture if externally mixed.

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PROCEDURE:
(Continued)

2. Instrumental Parameters:

A. Cycle solvent mixture throughout the system at 2 mLs/minute. Equilibration is reached within one hour, usually. Set the detector wavelength to 260 nm UV and turn lamp on.

B. If solvent outgas is noticed (bubbles in cell), place a restrictor coil on the outlet liquid line of the detector. Do not exceed cell pressure maximum (see detector manual).

3. Standard Preparation:

Prepare standards from technical grade Cobratech TT-100 powder, assay~98%. Accurately weigh 0.10g TT-100 into a 100 mL volumetric flask and dilute to volume with methanol. Label flask; 1000 ppm TTA stock solution. Serial dilutions in eluent from this stock solution are prepared to accommodate sample concentration, typically 3 ppm to 16% assay. Working standard concentrations of 5 to 50 ppm are suitable.

4. Calibration:

The calibration curve is linear from 1 to 250 ppm. See attached plot. Standards and samples should be properly diluted to fall within this range. Duplicate injections of standards or samples should not show more than a 2% variation in peak area or height. Retention time for TTA is approximately 8-9 minutes. See attached chromatogram.

5. Sample Preparation:

Actual cooling tower samples should not be diluted since levels of <10 ppm TTA are common. Assay levels, as in 562C, should be diluted sufficiently to fall within calibration range, i.e. 0.1 g/l→dilution of 10000.

CALCULATIONS:

The LAS computer can generate a linear least squares fit of peak height (or area) vs. concentration (ppm) and calculate concentration of TTA in samples. This program is suggested to obtain linearity data.

STATISTICS:

A relative standard deviation of <1% was observed in peak height for standards and samples.

Spiked recovery analysis in water provided 98% minimum recovery at levels of 10 to 100 ppm TTA.

DISCUSSION: Tolyltriazole appears to exist as a mixture of isomers. Under these LC conditions it is possible to partially resolve this mixture which leads to assymetric peaks. The total area of any assymetric tolyltriazole peak should be summed for calibration purposes. Chlorination of TTA does interfere but quantitation of TTA is still possible, see illustration #3.

No sample or standard degradation was observed within a 24 hour period under ambient conditions.

REFERENCES: NB #1044: 55-58 DN

AUTHOR(S): W. G. Gaboda/D. W. Newman

Date: February 26, 1981

TTA LINEARITY VIA HPLC
CONCENTRATION IN PPM vs PEAK HEIGHT IN MM
Linear Least Squares Fit: Y=A+B*X
A=-1.57697 B=1.06947 Correlation Coefficient=.999047

X (ACTUAL)	Y (ACTUAL)	Y (CALCULATED)	% DIFFERENCE
0	0	-1.57697	1.70141E+38
1	1	-.507503	150.75
11	10	10.1872	1.87204
25	25	25.1598	.639191
50	50	51.8966	3.79314
97	100	102.162	2.1617
234	250	248.679	.528308

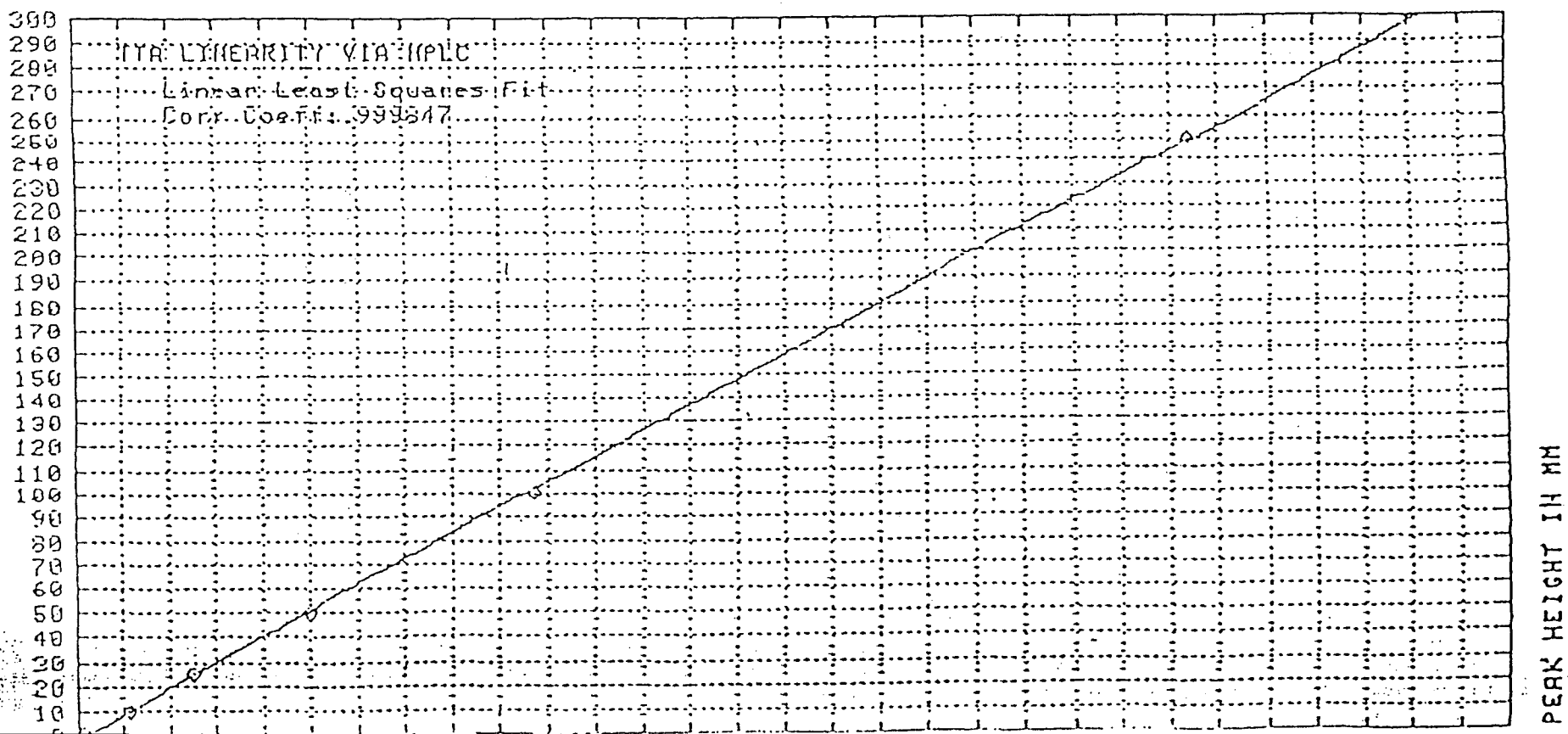

Figure 1.

APR-21-91 THU 12:44 BETZ LABS THE WOODLANDS P.04

ATTACHMENT

Question 13

Evaluation of Potential Effects from Long-Term Buildup of Radioactivity in the Aquatic Environment Surrounding Watts Bar Nuclear Plant

Buildup in River Sediment

To estimate the buildup of radioactive material in river sediments due to the long-term release of radioactive material in liquid effluents released from the Watts Bar Nuclear Plant, Equation A-4 from Regulatory Guide 1.109 is used. This equation is:

$$C_{is} = K_c \{C_{iw} [1 - \exp(-\lambda_i t_b)]/\lambda_i\}$$

where

C_{is} is the concentration of radionuclide in sediment in pCi/kg;
K_c is an assumed transfer constant from water to sediment, in liters/kg per hour. The value used for this factor (0.072) is taken from Equation A-5 of Regulatory Guide 1.109;
C_{iw} is the concentration of nuclide i in water adjacent to the sediment, in pCi/l
t_b is the length of time the sediment is exposed to the contaminated water, set equal to 40 years in this case, the expected operating lifetime for Watts Bar;
λ_i is the decay constant of nuclide i, in hours^{-1}.

The estimated releases of radioactivity in WBN liquid effluents is given in Table 1. From this list, those nuclides whose half-lives are longer than 1 year were selected for this evaluation. Those nuclides are marked by an asterisk in Table 1. To estimate the value of C_{iw} for the calculation, the annual releases for each radionuclide to be considered is divided by the total volume of dilution water available in the Tennessee River. This total volume is determined by using the average flow rate of 20,000 cubic feet per second (cfs) for a one year period multiplied by a factor of 0.1 (the assumed fraction of the riverflow which is available for immediate entrainment of the effluent):

$$C_{iw} = (C_i*1.00E+12)/(2.0E+04*0.1*3.15E+07*2.832E+04*0.001)$$

where

C_i is the concentration of nuclide i, in pCi;
1.00E+12 is a conversion factor, pCi/Ci;
2.00E+04 is the average riverflow past Watts Bar for the period 1985-1989, from the Watts Bar Offsite Dose Calculation Manual;
0.1 is the fraction of the riverflow available for immediate entrainment and dilution of the liquid effluent released from Watts Bar, as defined in the Watts Bar Offsite Dose Calculation Manual;
3.15E+07 is a conversion factor, seconds/year;
2.832E+04 is a conversion faction ml per cubic foot;
0.001 is a conversion faction, liters/ml.

These concentration values for each of the applicable nuclides is given in Table 2.

Evaluation of Potential Effects from Long-Term Buildup of Radioactivity in the Aquatic Environment Surrounding Watts Bar Nuclear Plant

The results of the calculation of estimated sediment concentration buildup over a 40-year period are given in Table 2. Also shown in the table are typical Radiological Environmental Monitoring Program (REMP) Lower Limits of Detection (LLDs) for the selected radionuclides.

The sediment concentrations given in Table 2 are then used to determine the dose rate to an individual standing on the shoreline of the river. The equation used for this determination is:

$$DR = DF_i * C_{is} * M * W$$

where

DR is the dose rate to an individual, in mrem/hour,
DF_i is the dose factor for nuclide i for standing on contaminated ground, mrem/hour per pCi/M^2, taken from Table E-6 of Regulatory Guide 1.109;
C_{is} is the concentration of nuclide i in the river sediment, pCi/kg
M is the mass of the segment, set equal to 40 kg/m^2, from Regulatory Guide 1.109.
W is the shoreline width factor to describe the geometry, set equal to 0.2 (from Regulatory Guide 1.109, Table A.2).

The dose rate for each nuclide, and the resulting total dose rate are given in Table 3. Using the calculated dose rate, the dose to an individual for an entire year will be:

$$D = DR * 8760$$

where

D is the dose to an individual for a year due to standing on contaminated ground at the river shoreline, mrem;
DR is the dose rate determined above, mrem/hour;
8760 is the number of hours in a year.

Inserting the total dose rate from Table 3 into the equation above yields a total individual dose of 1.65 mrem for an exposure time of 8760 per year.

Buildup in Aquatic Biota

The concentrations in aquatic foods can be determined using Equation A-3 from Regulatory Guide 1.109:

$$C_{ia} = C_{iw} * B_i$$

where

C_{iw} is the concentration of nuclide i in the water, pCi/Liter;
C_{ia} is the concentration of nuclide i in the biota, pCi/kg;
B_i is the equilibrium bioaccumulation factor for fish or invertebrates for nuclide i, pCi/kg per pCi/Liter.

Evaluation of Potential Effects from Long-Term Buildup of Radioactivity in the Aquatic Environment Surrounding Watts Bar Nuclear Plant

The estimated equilibrium concentrations in biota for the nuclides under consideration are given in Table 4. To then obtain the dose due to ingestion of these biota, the following equation is used.

$$D = U_{ap} * C_{ia} * DF_i$$

U_{ap} is the ingestion rate for fish or invertebrates, kg/year from Regulatory Guide 1.109 Table E-5; the teen maximum ingestion rate values of 16 and 3.8, respectively, from Regulatory guide 1.109 Table E-5, are used for this determination.

C_{ia} is the concentration of nuclide i in the biota, pCi/kg;

DF_i is the teen ingestion dose conversion factor for nuclide i, mrem/pCi, from Regulatory Guide 1.109, Table E-12.

The resulting doses to individuals due to the ingestion of fish and clams from the Tennessee River at the end of the operating life of Watts Bar are tabulated in Table 5.

Conclusions

An estimate of the potential total dose to the maximum individual due to the buildup of radioactivity in the environment surrounding Watts Bar Nuclear Plant from the release of radioactive material in the liquid effluent is the sum of the pathway doses calculated above. The total dose is calculated to be 4.03 mrem. This is a conservative estimate due to the exposure times and ingestion rates used in the calculation. In addition, not all of the pathways considered actually exist around Watts Bar. Currently, there is no identified pathway for the ingestion of invertebrates from the Tennessee River; however, this pathway was included in this evaluation for conservatism. This estimated dose of 4.03 mrem is within the 10 CFR Part 50, Appendix I guideline of 5 mrem to the total body or any organ of an individual in an unrestricted area from all pathways due to the annual release of radioactive material from all light-water-cooled nuclear power reactors at a site. The estimates of radioactivity to be released from Watts Bar, taken from the Watts Bar Final Safety Analysis Report are the upper bounding releases for the liquid radwaste treatment systems to be used at the plant, actual releases are expected to be much lower that these estimates. Therefore, there should be no significant impact due to the buildup of long-lived radionuclides in the aquatic environment surrounding Watts Bar.

Evaluation of Potential Effects from Long-Term Buildup of Radioactivity in the Aquatic Environment Surrounding Watts Bar Nuclear Plant

Table 1
WBN Total Annual Liquid Effluent Discharge
(for two unit operation)

Nuclide	Half-life (year)	Release (Ci/year)	Nuclide	Half-life (year)	Release (Ci/year)
BR-84	0.00006	5.39E-02	Y-91	0.16039	3.94E-04
I-131	0.02207	1.37E+00	Y-93	0.00115	8.00E-02
I-132	0.00026	2.04E+00	Zr-95	0.17542	1.62E-02
I-133	0.00238	3.41E+00	Nb-95	0.09608	8.90E-03
I-134	0.00010	1.67E+00	Mo-99	0.00753	1.86E-01
I-135	0.00076	4.35E+00	To-99m	0.00069	1.47E-01
Rb-88	0.00003	7.05E-01	Ru-103	0.10788	2.60E-01
*Cs-134	2.05479	3.01E-01	*Ru-106	1.00837	2.87E+00
Cs-136	0.03615	3.41E-02	Ag-110m	0.68493	4.21E-02
*Cs-137	30.25114	4.00E-01	Te-129m	0.09209	6.05E-03
Na-24	0.00171	1.04E+00	Te-129	0.00013	1.22E-01
Cr-51	0.07591	1.09E-01	Te-131m	0.00342	3.95E-02
Mn-54	0.85616	5.89E-02	Te-131	0.00005	1.89E-02
*Fe-55	2.70167	5.30E-02	Te-132	0.00892	5.02E-02
Fe-59	0.12234	1.39E-02	Ba-140	0.03501	4.11E-01
Co-58	0.19406	1.62E-01	La-140	0.00459	7.22E-01
*Co-60	5.27017	4.51E-02	Ce-141	0.08904	5.26E-03
Zn-65	0.66971	1.62E-02	Ce-143	0.00377	7.47E-02
Sr-89	0.13851	4.68E-03	Ce-144	0.77816	1.35E-01
*Sr-90	28.52881	4.16E-04	Pr-143	0.03710	4.67E-02
Sr-91	0.00108	1.81E-02	Pr-144	0.00003	1.30E-01
Y-91m	0.00009	5.01E-03	Np-239	0.00645	6.29E-02
			TOTAL		2.16E+01

Evaluation of Potential Effects from Long-Term Buildup of Radioactivity in the Aquatic Environment Surrounding Watts Bar Nuclear Plant

Table 2

	Total Released	Diluted Concentration	Sediment Concentration	Environmental Sample LLD
	Ci/year	(pCi/ml)	(pCi/kg)	pCi/kg)
Cs-134	3.01E-01	1.20E-02	3.15E+02	30
Cs-137	4.00E-01	1.60E-02	3.70E+03	30
Fe-55	5.30E-02	2.12E-03	7.30E+01	N/A
Co-60	4.51E-02	1.81E-03	1.21E+02	30
Sr-90	4.16E-04	1.67E-05	3.76E+00	400
Ru-106	2.87E+00	1.15E-01	1.48E+03	200

Table 3

	Sediment Concentration	Dose Factor	Dose Rate
	(pCi/kg)	(mrem/hour per pCi/m^2)	(mrem/hour)
Cs-134	3.15E+02	1.2E-08	3.02E-04
Cs-137	3.70E+03	4.2E-09	1.24E-04
Fe-55	7.30E+01	0.0	0.0
Co-60	1.21E+02	1.7E-08	1.65E-05
Sr-90	3.76E+00	0.0	0.0
Ru-106	1.48E+03	1.5E-09	8.88E-05
Total			1.89E-04

Evaluation of Potential Effects from Long-Term Buildup of Radioactivity in the Aquatic Environment Surrounding Watts Bar Nuclear Plant

Table 4

	Diluted Concentration	Bioaccumulation Factors		Fish Concentration	Clam Concentration
	pCi/kg	Fish	Clams	pCi/kg	pCi/kg
Cs-134	1.69E-01	2.00E+03	1000	3.37E+02	1.69E+02
Cs-137	2.24E-01	2.00E+03	1000	4.48E+02	2.24E+02
Fe-55	2.97E-02	100	3200	2.97E+00	9.50E+01
Co-60	2.53E-02	5.00E+01	2.00E+02	1.26E+00	5.06E+00
Sr-90	2.33E-04	3.00E+01	1.00E+02	6.99E-03	2.33E-02
Ru-106	1.61E+00	1.00E+01	3.00E+01	1.61E+01	4.82E+01

Table 5

	Bone Dose Factor	Liver Dose Factor	GI-LLI Dose Factor	Bone Ingestion Dose	Liver Ingestion Dose	GI-LLI Ingestion Dose
	(mrem/pCi)			(mrem)		
Cs-134	8.37E-05	1.97E-04	2.45E-06	5.05E-01	1.19E+00	1.48E-02
Cs-137	1.12E-04	1.49E-04	2.12E-06	8.98E-01	1.19E+00	1.70E-02
Fe-55	3.78E-06	2.68E-06	1.16E-06	1.54E-03	1.10E-03	4.74E-04
Co-60	0.0	2.81E-06	3.66E-05	0.00E+00	1.11E-04	1.44E-03
Sr-90	8.3E-03	0.00E+00	2.33E-04	1.66E-03	0.00E+00	4.67E-05
Ru-106	3.92E-06	0.00E+00	1.88E-04	1.73E-03	0.00E+00	8.28E-02
Total				1.41E+00	2.38E+00	1.17E-01

ATTACHMENT

Question 14

JOINT PERCENTAGE FREQUENCIES OF WIND SPEED BY WIND DIRECTION FOR

STABILITY CLASS A (DELTA T<=-1.9 C/100 M)

WATTS BAR NUCLEAR PLANT

JAN 1, 74 - DEC 31, 93

WIND DIRECTION	WIND SPEED(MPH) CALM	0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	>=24.5	TOTAL
N	0.000	0.001	0.008	0.021	0.036	0.060	0.003	0.000	0.000	0.129
NNE	0.000	0.001	0.012	0.054	0.074	0.141	0.004	0.000	0.000	0.285
NE	0.000	0.000	0.035	0.088	0.078	0.089	0.000	0.000	0.000	0.289
ENE	0.000	0.001	0.037	0.079	0.071	0.032	0.000	0.000	0.000	0.220
E	0.000	0.002	0.037	0.041	0.015	0.005	0.000	0.000	0.000	0.100
ESE	0.000	0.000	0.016	0.016	0.002	0.001	0.000	0.000	0.000	0.035
SE	0.000	0.001	0.021	0.027	0.005	0.001	0.001	0.000	0.000	0.055
SSE	0.000	0.001	0.042	0.055	0.020	0.013	0.002	0.000	0.000	0.133
S	0.000	0.002	0.058	0.139	0.127	0.129	0.018	0.001	0.000	0.473
SSW	0.000	0.001	0.046	0.257	0.476	0.743	0.113	0.005	0.000	1.639
SW	0.000	0.000	0.018	0.093	0.118	0.102	0.012	0.000	0.000	0.343
WSW	0.000	0.000	0.006	0.016	0.017	0.063	0.021	0.002	0.000	0.125
W	0.000	0.000	0.004	0.010	0.014	0.064	0.014	0.001	0.000	0.106
WNW	0.000	0.000	0.001	0.004	0.007	0.033	0.005	0.000	0.000	0.050
NW	0.000	0.000	0.003	0.005	0.010	0.029	0.006	0.000	0.000	0.052
NNW	0.000	0.001	0.007	0.021	0.035	0.057	0.011	0.000	0.000	0.131
SUBTOTAL	0.001	0.008	0.350	0.925	1.102	1.563	0.210	0.008	0.000	4.166

TOTAL HOURS OF VALID STABILITY OBSERVATIONS	167789
TOTAL HOURS OF STABILITY CLASS A	6970
TOTAL HOURS OF VALID WIND DIRECTION-WIND SPEED-STABILITY CLASS A	6849
TOTAL HOURS OF VALID WIND DIRECTION-WIND SPEED-STABILITY OBSERVATIONS	164406
TOTAL HOURS CALM	1

METEOROLOGICAL FACILITY: WATTS BAR NUCLEAR PLANT
STABILITY BASED ON DELTA-T BETWEEN 9.51 AND 45.63 METERS
WIND SPEED AND DIRECTION MEASURED AT 9.72 METER LEVEL

DATE PRINTED: 16-SEP-94

MEAN WIND SPEED = 7.21

NOTE: TOTALS AND SUBTOTALS ARE OBTAINED FROM UNROUNDED NUMBERS

JOINT PERCENTAGE FREQUENCIES OF WIND SPEED BY WIND DIRECTION FOR

STABILITY CLASS B (-1.9< DELTA T<=-1.7 C/100 M)

WATTS BAR NUCLEAR PLANT

JAN 1, 74 - DEC 31, 93

WIND DIRECTION	WIND SPEED(MPH) CALM	0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	>=24.5	TOTAL
N	0.000	0.000	0.021	0.055	0.052	0.080	0.007	0.000	0.000	0.213
NNE	0.000	0.001	0.040	0.108	0.112	0.186	0.012	0.000	0.000	0.458
NE	0.000	0.000	0.069	0.123	0.107	0.086	0.002	0.000	0.000	0.387
ENE	0.000	0.001	0.052	0.101	0.071	0.024	0.000	0.000	0.000	0.249
E	0.000	0.001	0.061	0.055	0.015	0.002	0.000	0.000	0.000	0.133
ESE	0.000	0.002	0.021	0.024	0.002	0.001	0.000	0.000	0.000	0.049
SE	0.000	0.000	0.030	0.028	0.003	0.002	0.001	0.000	0.000	0.064
SSE	0.000	0.001	0.046	0.046	0.013	0.005	0.000	0.000	0.000	0.111
S	0.000	0.001	0.052	0.128	0.077	0.054	0.012	0.002	0.000	0.326
SSW	0.000	0.000	0.068	0.211	0.289	0.238	0.046	0.003	0.000	0.855
SW	0.000	0.000	0.027	0.114	0.080	0.029	0.003	0.000	0.000	0.252
WSW	0.000	0.000	0.007	0.024	0.026	0.023	0.007	0.000	0.000	0.085
W	0.000	0.000	0.005	0.010	0.023	0.049	0.012	0.001	0.000	0.099
WNW	0.000	0.000	0.005	0.005	0.019	0.060	0.007	0.000	0.000	0.097
NW	0.000	0.000	0.007	0.013	0.023	0.063	0.005	0.001	0.000	0.112
NNW	0.000	0.000	0.008	0.027	0.033	0.081	0.010	0.001	0.000	0.161
SUBTOTAL	0.000	0.006	0.519	1.072	0.944	0.982	0.123	0.007	0.000	3.654

TOTAL HOURS OF VALID STABILITY OBSERVATIONS	167789
TOTAL HOURS OF STABILITY CLASS B	6109
TOTAL HOURS OF VALID WIND DIRECTION-WIND SPEED-STABILITY CLASS B	6007
TOTAL HOURS OF VALID WIND DIRECTION-WIND SPEED-STABILITY OBSERVATIONS	164406
TOTAL HOURS CALM	0

METEOROLOGICAL FACILITY: WATTS BAR NUCLEAR PLANT
STABILITY BASED ON DELTA-T BETWEEN 9.51 AND 45.63 METERS
WIND SPEED AND DIRECTION MEASURED AT 9.72 METER LEVEL

DATE PRINTED: 16-SEP-94

MEAN WIND SPEED = 6.38

NOTE: TOTALS AND SUBTOTALS ARE OBTAINED FROM UNROUNDED NUMBERS

JOINT PERCENTAGE FREQUENCIES OF WIND SPEED BY WIND DIRECTION FOR

STABILITY CLASS C (-1.7< DELTA T<=-1.5 C/100 M)

WATTS BAR NUCLEAR PLANT

JAN 1, 74 - DEC 31, 93

WIND DIRECTION	WIND SPEED(MPH) CALM	0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	>=24.5	TOTAL
N	0.000	0.001	0.041	0.099	0.117	0.154	0.008	0.000	0.000	0.419
NNE	0.000	0.001	0.099	0.205	0.221	0.292	0.019	0.000	0.000	0.837
NE	0.000	0.002	0.130	0.234	0.163	0.128	0.001	0.000	0.000	0.658
ENE	0.000	0.001	0.117	0.172	0.082	0.027	0.001	0.000	0.000	0.400
E	0.000	0.004	0.101	0.126	0.022	0.005	0.001	0.000	0.000	0.258
ESE	0.000	0.002	0.041	0.040	0.004	0.000	0.000	0.000	0.000	0.088
SE	0.000	0.001	0.055	0.056	0.008	0.001	0.002	0.000	0.000	0.123
SSE	0.000	0.001	0.085	0.109	0.029	0.012	0.004	0.000	0.000	0.238
S	0.000	0.001	0.116	0.245	0.114	0.068	0.017	0.001	0.000	0.561
SSW	0.000	0.001	0.099	0.418	0.375	0.268	0.062	0.004	0.000	1.227
SW	0.000	0.001	0.049	0.193	0.103	0.036	0.007	0.000	0.000	0.388
WSW	0.000	0.001	0.021	0.057	0.037	0.023	0.009	0.000	0.000	0.148
W	0.000	0.001	0.018	0.027	0.050	0.060	0.011	0.002	0.000	0.169
WNW	0.000	0.000	0.011	0.022	0.038	0.113	0.018	0.000	0.000	0.201
NW	0.000	0.000	0.020	0.040	0.051	0.144	0.015	0.001	0.000	0.270
NNW	0.000	0.000	0.024	0.056	0.081	0.129	0.011	0.000	0.000	0.301
SUBTOTAL	0.000	0.015	1.027	2.097	1.494	1.460	0.184	0.009	0.000	6.286

TOTAL HOURS OF VALID STABILITY OBSERVATIONS 167789
TOTAL HOURS OF STABILITY CLASS C 10556
TOTAL HOURS OF VALID WIND DIRECTION-WIND SPEED-STABILITY CLASS C 10335
TOTAL HOURS OF VALID WIND DIRECTION-WIND SPEED-STABILITY OBSERVATIONS 164406
TOTAL HOURS CALM 0

METEOROLOGICAL FACILITY: WATTS BAR NUCLEAR PLANT
STABILITY BASED ON DELTA-T BETWEEN 9.51 AND 45.63 METERS
WIND SPEED AND DIRECTION MEASURED AT 9.72 METER LEVEL

DATE PRINTED: 16-SEP-94

MEAN WIND SPEED = 6.06

NOTE: TOTALS AND SUBTOTALS ARE OBTAINED FROM UNROUNDED NUMBERS

JOINT PERCENTAGE FREQUENCIES OF WIND SPEED BY WIND DIRECTION FOR

STABILITY CLASS D (-1.5< DELTA T<=-0.5 C/100 M)

WATTS BAR NUCLEAR PLANT

JAN 1, 74 - DEC 31, 93

WIND DIRECTION	WIND SPEED(MPH) CALM	0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	>=24.5	TOTAL
N	0.005	0.046	0.502	0.875	0.968	1.192	0.046	0.000	0.000	3.634
NNE	0.006	0.043	0.584	1.226	1.348	1.457	0.063	0.000	0.000	4.729
NE	0.008	0.067	0.727	1.043	0.615	0.355	0.009	0.001	0.000	2.824
ENE	0.010	0.108	0.860	0.586	0.159	0.052	0.001	0.000	0.000	1.775
E	0.007	0.135	0.568	0.260	0.064	0.016	0.000	0.000	0.000	1.050
ESE	0.003	0.070	0.245	0.082	0.013	0.007	0.000	0.000	0.000	0.420
SE	0.005	0.078	0.378	0.151	0.029	0.023	0.007	0.000	0.000	0.670
SSE	0.007	0.130	0.591	0.256	0.052	0.046	0.018	0.002	0.000	1.102
S	0.011	0.133	0.991	0.816	0.339	0.294	0.100	0.011	0.001	2.697
SSW	0.014	0.106	1.259	1.837	1.071	1.119	0.246	0.021	0.000	5.671
SW	0.009	0.129	0.784	0.742	0.249	0.151	0.018	0.001	0.001	2.084
WSW	0.006	0.083	0.498	0.335	0.170	0.121	0.029	0.001	0.000	1.243
W	0.005	0.095	0.408	0.336	0.347	0.409	0.044	0.002	0.000	1.647
WNW	0.004	0.098	0.325	0.359	0.436	0.571	0.055	0.003	0.000	1.851
NW	0.004	0.080	0.341	0.398	0.530	0.748	0.069	0.001	0.000	2.171
NNW	0.004	0.048	0.370	0.526	0.626	0.903	0.047	0.000	0.000	2.524
SUBTOTAL	0.108	1.450	9.430	9.829	7.016	7.464	0.751	0.042	0.001	36.091

TOTAL HOURS OF VALID STABILITY OBSERVATIONS 167789
TOTAL HOURS OF STABILITY CLASS D 60312
TOTAL HOURS OF VALID WIND DIRECTION-WIND SPEED-STABILITY CLASS D 59336
TOTAL HOURS OF VALID WIND DIRECTION-WIND SPEED-STABILITY OBSERVATIONS 164406
TOTAL HOURS CALM 177

METEOROLOGICAL FACILITY: WATTS BAR NUCLEAR PLANT
STABILITY BASED ON DELTA-T BETWEEN 9.51 AND 45.63 METERS
WIND SPEED AND DIRECTION MEASURED AT 9.72 METER LEVEL

DATE PRINTED: 16-SEP-94

MEAN WIND SPEED = 5.37

NOTE: TOTALS AND SUBTOTALS ARE OBTAINED FROM UNROUNDED NUMBERS

JOINT PERCENTAGE FREQUENCIES OF WIND SPEED BY WIND DIRECTION FOR

STABILITY CLASS E (-0.5< DELTA T<= 1.5 C/100 M)

WATTS BAR NUCLEAR PLANT

JAN 1, 74 - DEC 31, 93

WIND DIRECTION	CALM	0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	>=24.5	TOTAL
				WIND SPEED(MPH)						
N	0.030	0.164	0.499	0.599	0.272	0.082	0.002	0.000	0.000	1.647
NNE	0.025	0.138	0.415	0.422	0.213	0.070	0.003	0.000	0.000	1.286
NE	0.030	0.156	0.513	0.266	0.088	0.030	0.000	0.000	0.000	1.085
ENE	0.057	0.280	0.988	0.289	0.040	0.009	0.001	0.000	0.000	1.662
E	0.034	0.304	0.461	0.083	0.016	0.010	0.001	0.000	0.000	0.910
ESE	0.013	0.148	0.147	0.028	0.007	0.002	0.001	0.000	0.000	0.347
SE	0.019	0.208	0.209	0.049	0.030	0.021	0.004	0.000	0.000	0.539
SSE	0.039	0.341	0.519	0.114	0.059	0.066	0.014	0.001	0.000	1.152
S	0.067	0.450	1.037	0.478	0.206	0.186	0.061	0.007	0.000	2.492
SSW	0.090	0.505	1.499	1.117	0.743	0.751	0.148	0.016	0.000	4.869
SW	0.071	0.566	1.008	0.300	0.176	0.131	0.021	0.002	0.000	2.274
WSW	0.063	0.651	0.763	0.178	0.106	0.071	0.010	0.001	0.000	1.844
W	0.059	0.671	0.645	0.222	0.111	0.067	0.008	0.000	0.000	1.783
WNW	0.055	0.626	0.595	0.214	0.091	0.037	0.002	0.001	0.000	1.622
NW	0.059	0.652	0.664	0.256	0.111	0.049	0.002	0.000	0.000	1.793
NNW	0.039	0.349	0.512	0.308	0.146	0.075	0.002	0.000	0.000	1.430
SUBTOTAL	0.748	6.208	10.476	4.924	2.414	1.656	0.280	0.028	0.000	26.733

TOTAL HOURS OF VALID STABILITY OBSERVATIONS	167789
TOTAL HOURS OF STABILITY CLASS E	44959
TOTAL HOURS OF VALID WIND DIRECTION-WIND SPEED-STABILITY CLASS E	43951
TOTAL HOURS OF VALID WIND DIRECTION-WIND SPEED-STABILITY OBSERVATIONS	164406
TOTAL HOURS CALM	1229

METEOROLOGICAL FACILITY: WATTS BAR NUCLEAR PLANT
STABILITY BASED ON DELTA-T BETWEEN 9.51 AND 45.63 METERS
WIND SPEED AND DIRECTION MEASURED AT 9.72 METER LEVEL

DATE PRINTED: 16-SEP-94

MEAN WIND SPEED = 3.28

NOTE: TOTALS AND SUBTOTALS ARE OBTAINED FROM UNROUNDED NUMBERS

JOINT PERCENTAGE FREQUENCIES OF WIND SPEED BY WIND DIRECTION FOR

STABILITY CLASS F (1.5< DELTA T<= 4.0 C/100 M)

WATTS BAR NUCLEAR PLANT

JAN 1, 74 - DEC 31, 93

WIND DIRECTION	WIND SPEED(MPH) CALM	0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	>=24.5	TOTAL
N	0.051	0.288	0.245	0.027	0.006	0.001	0.000	0.000	0.000	0.617
NNE	0.043	0.230	0.219	0.027	0.001	0.001	0.000	0.000	0.000	0.520
NE	0.054	0.246	0.318	0.025	0.002	0.001	0.000	0.000	0.000	0.645
ENE	0.087	0.345	0.567	0.058	0.002	0.002	0.000	0.000	0.000	1.062
E	0.046	0.286	0.200	0.010	0.001	0.001	0.000	0.000	0.000	0.544
ESE	0.016	0.120	0.048	0.001	0.000	0.000	0.000	0.000	0.000	0.185
SE	0.023	0.159	0.082	0.005	0.001	0.000	0.000	0.000	0.000	0.270
SSE	0.042	0.254	0.189	0.018	0.002	0.002	0.000	0.000	0.000	0.508
S	0.061	0.338	0.304	0.040	0.005	0.004	0.000	0.000	0.000	0.751
SSW	0.078	0.387	0.435	0.175	0.063	0.013	0.000	0.000	0.000	1.151
SW	0.096	0.517	0.498	0.064	0.018	0.005	0.001	0.000	0.000	1.199
WSW	0.126	0.738	0.588	0.038	0.007	0.001	0.000	0.000	0.000	1.497
W	0.131	0.884	0.499	0.028	0.001	0.001	0.000	0.000	0.000	1.544
WNW	0.126	0.937	0.393	0.024	0.002	0.001	0.000	0.000	0.000	1.483
NW	0.184	1.226	0.707	0.041	0.004	0.002	0.001	0.000	0.000	2.164
NNW	0.099	0.644	0.398	0.030	0.004	0.000	0.000	0.000	0.000	1.175
SUBTOTAL	1.262	7.599	5.690	0.609	0.119	0.035	0.001	0.000	0.000	15.315

TOTAL HOURS OF VALID STABILITY OBSERVATIONS	167789
TOTAL HOURS OF STABILITY CLASS F	25810
TOTAL HOURS OF VALID WIND DIRECTION-WIND SPEED-STABILITY CLASS F	25178
TOTAL HOURS OF VALID WIND DIRECTION-WIND SPEED-STABILITY OBSERVATIONS	164406
TOTAL HOURS CALM	2075

METEOROLOGICAL FACILITY: WATTS BAR NUCLEAR PLANT
STABILITY BASED ON DELTA-T BETWEEN 9.51 AND 45.63 METERS
WIND SPEED AND DIRECTION MEASURED AT 9.72 METER LEVEL

DATE PRINTED: 16-SEP-94

MEAN WIND SPEED = 1.53

NOTE: TOTALS AND SUBTOTALS ARE OBTAINED FROM UNROUNDED NUMBERS

JOINT PERCENTAGE FREQUENCIES OF WIND SPEED BY WIND DIRECTION FOR

STABILITY CLASS G (DELTA T > 4.0 C/100 M)

WATTS BAR NUCLEAR PLANT

JAN 1, 74 - DEC 31, 93

WIND DIRECTION	CALM	0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	>=24.5	TOTAL
				WIND SPEED(MPH)						
N	0.034	0.195	0.066	0.001	0.000	0.000	0.000	0.000	0.000	0.296
NNE	0.038	0.196	0.095	0.002	0.000	0.000	0.000	0.000	0.000	0.330
NE	0.054	0.257	0.161	0.001	0.000	0.000	0.000	0.000	0.000	0.473
ENE	0.091	0.376	0.327	0.008	0.000	0.001	0.000	0.000	0.000	0.803
E	0.047	0.257	0.105	0.002	0.000	0.000	0.000	0.000	0.000	0.411
ESE	0.015	0.095	0.024	0.000	0.000	0.000	0.000	0.000	0.000	0.135
SE	0.027	0.159	0.049	0.000	0.000	0.000	0.000	0.000	0.000	0.235
SSE	0.031	0.176	0.065	0.002	0.000	0.000	0.000	0.000	0.000	0.274
S	0.035	0.192	0.075	0.005	0.001	0.000	0.000	0.000	0.000	0.308
SSW	0.042	0.217	0.107	0.012	0.002	0.000	0.000	0.000	0.000	0.379
SW	0.053	0.278	0.130	0.005	0.000	0.000	0.000	0.000	0.000	0.466
WSW	0.089	0.436	0.251	0.007	0.000	0.000	0.000	0.000	0.000	0.782
W	0.094	0.464	0.260	0.005	0.000	0.000	0.000	0.000	0.000	0.823
WNW	0.075	0.406	0.172	0.004	0.000	0.000	0.000	0.000	0.000	0.656
NW	0.101	0.516	0.263	0.010	0.001	0.000	0.000	0.000	0.000	0.892
NNW	0.056	0.306	0.128	0.003	0.000	0.000	0.000	0.000	0.000	0.494
SUBTOTAL	0.881	4.524	2.278	0.068	0.004	0.001	0.000	0.000	0.000	7.755

TOTAL HOURS OF VALID STABILITY OBSERVATIONS	167789
TOTAL HOURS OF STABILITY CLASS G	13073
TOTAL HOURS OF VALID WIND DIRECTION-WIND SPEED-STABILITY CLASS G	12750
TOTAL HOURS OF VALID WIND DIRECTION-WIND SPEED-STABILITY OBSERVATIONS	164406
TOTAL HOURS CALM	1448

METEOROLOGICAL FACILITY: WATTS BAR NUCLEAR PLANT
STABILITY BASED ON DELTA-T BETWEEN 9.51 AND 45.63 METERS
WIND SPEED AND DIRECTION MEASURED AT 9.72 METER LEVEL

DATE PRINTED: 16-SEP-94

MEAN WIND SPEED = 1.23

NOTE: TOTALS AND SUBTOTALS ARE OBTAINED FROM UNROUNDED NUMBERS

ATTACHMENT

Question 15

METEOROLOGICAL DATA

LOCATION: Watts Bar Nuclear Plant
PERIOD OF RECORD: January 1, 1989 - December 31, 1993

Meterological Value	
I6	Identifier
I2	Year
I3	Julian Day
I4	Hour
F5.1	Upper Measurements: Level = 91.20 meters (m)
F5.1	Wind Direction (degrees)
F5.1	Wind Speed (mps)
F5.1	-
F5.1	Ambient Temperature (degrees C)
F5.1	-
F5.1	-
F5.1	Intermediate Measurements: Level = 45.63 meters (m)
F5.1	Wind Direction (degrees)
F5.1	Wind Speed (mps)
F5.1	-
F5.1	Ambient Temperature (degrees C)
F5.1	-
F5.1	-
F5.1	Lower Measurements: Level = 9.51 meters (m)
F5.1	Wind Direction (degrees)
F5.1	Wind Speed (mps)
F5.1	-
F5.1	Ambient Temperature (degrees C)
F5.1	-
F5.1	Dew Point Temperature (degrees C)
F5.1	Temperature Difference (Upper - Lower) (degrees C/100m)
F5.1	Temperature Difference (Upper - Inter) (degrees C/100m)
F5.1	Temperature Difference (Inter - Lower) (degrees C/100m)
F5.1	Precipitation (mm)
F5.1	Solar Radiation (ly/min)
F5.1	-
F5.1	-
F5.1	-

Contents of diskette:

```
NRCWBNP  FMT          1,682 10-26-94  10:25a  -  File format for met data
NRCWBN89 ZIP        238,084 10-26-94   9:56a  -  Compressed file for 1989
NRCWBN90 ZIP        243,214 10-26-94   9:56a  -      "       "    "  1990
NRCWBN91 ZIP        241,075 10-26-94   9:57a  -      "       "    "  1991
NRCWBN92 ZIP        241,950 10-26-94   9:57a  -      "       "    "  1992
NRCWBN93 ZIP        242,342 10-26-94   9:57a  -      "       "    "  1993
PKUNZIP  EXE         18,208 03-06-89  12:00a  -  PKUNZIP utility
PKZIP    EXE         26,796 03-06-89  12:00a  -  PKZIP utility
        8 file(s)      1,253,351 bytes
                         201,728 bytes free
```

The files on the diskette are compressed using the pkzip utility. Assuming your 3.5" disk drive is drive b:, change default drive to drive b: and enter the following for each file to decompress.

```
b:> PKUNZIP NRCWBN89.ZIP C:
```

This will create file NRCWBN89.DAT in your root directory on drive c:.

You may use wildcards to decompress all files:

```
b:> PKUNZIP *.* C:
```

Note: For help with PKUNZIP, enter PKUNZIP/h
PKZIP is included if you want it.

```
PKUNZIP (tm)    FAST!    Extract Utility    Version 0.92    03-06-89
Copyright 1989 PKWARE Inc.  All Rights Reserved.  PKUNZIP/h for help

Extracts files from a zipfile to their original name,size,date & attributes.

Usage: PKUNZIP [options] zipfile [d:path\] [file...]
Options are:
  -c[m] = extract to screen [with more]  -x = extract file(s) (default)
  -d = create directories stored in ZIP  -l = display software license
  -n = extract only newer files          -o = overwrite existing files
  -p[a,b,c][1,2,3] = extract to printer [Asc mode,Bin mode,Com port] [port #]
  -t = test zipfile integrity            -v = view filenames in ZIP(s)

zipfile = ZIP file name, wildcards *,? ok.  Default extension is .ZIP
d:path\ = Output drive and/or path.
file    = Name(s) of files to extract. Wildcards *,? ok. Default is ALL files.

If you find PKUNZIP fast, easy, and convenient to use, a registration of $25
would be appreciated.  If you send $47 or more you will receive, when
available, the next version of the PKZIP, PKUNZIP, and PKSFX programs.
Please state the version of the software that you currently have.  Send
check or money order to:   PKWARE, Inc.
                           7545 N. Port Washington Rd.
                           Glendale, WI 53217
Win C:\>
```

COMPARISON OF TENNESSEE VALLEY REGION WIND SPEED CONDITIONS FOR 1974-88 AND 1989-93

Plant Period of Record	BFN 1977-88	BFN 1989-93	SQN 1972-88	SQN 1989-93	WBN 1974-88	WBN 1989-93	CHA 1974-88	CHA 1989-93	TYS 1974-88	TYS 1989-93
Mean Wind Speed (mi/h)	5.3	4.6	4.6	3.8	4.2	3.6	4.9	4.6	5.6	5.0
Calms (% occurrence)	0.4	1.7	0.5	1.5	1.6	7.0	N/A	N/A	N/A	N/A
Ratio of longer-term to 5 years for mean wind speed	BFN =	1.15	SQN =	1.21	WBN =	1.17	CHA =	1.07	TYS =	1.12
Ratio of 5 years to longer-term for calm frequency	BFN =	4.25	SQN =	3.00	WBN =	4.38				

ATTACHMENT

Question 16

AVERAGE WIND SPEED (10-M)
WATTS BAR NUCLEAR PLANT
JANUARY 1974 - DECEMBER 1988

MONTH	HOUR	NUMBER OF VALID OBSERVATIONS	MEAN WIND SPEED AT 10-M (mi/h)
JANUARY	1-Jan	457	4.1
	2	457	4.1
	3	456	4.0
	4	453	4.0
	5	453	4.0
	6	453	4.1
	7	454	4.1
	8	459	4.2
	9	459	4.8
	10	450	5.3
	11	458	5.8
	12	457	6.0
	13	456	6.2
	14	459	6.3
	15	462	6.3
	16	463	6.1
	17	459	5.5
	18	462	4.8
	19	462	4.4
	20	461	4.4
	21	461	4.3
	22	459	4.3
	23	459	4.2
	24	458	4.1
	MONTH	10987	4.8
FEBRUARY	1-Feb	418	3.9
	2	419	3.9
	3	417	3.8
	4	414	3.9
	5	413	3.8
	6	415	3.7
	7	414	3.8
	8	413	4.0
	9	413	4.7
	10	412	5.3
	11	418	5.8
	12	417	6.2
	13	413	6.6
	14	416	7.0
	15	418	7.1
	16	416	6.9
	17	419	6.3
	18	419	5.4
	19	418	4.8
	20	420	4.5
	21	419	4.4
	22	418	4.9
	23	418	4.1
	24	419	4.0
	MONTH	9996	4.9

AVERAGE WIND SPEED (10-M)
WATTS BAR NUCLEAR PLANT
JANUARY 1974 - DECEMBER 1988

MONTH	HOUR	NUMBER OF VALID OBSERVATIONS	MEAN WIND SPEED AT 10-M (mi/h)
MARCH	1-Mar	450	3.8
	2	450	3.8
	3	450	3.8
	4	448	3.9
	5	446	3.8
	6	447	3.8
	7	445	4.0
	8	446	4.6
	9	447	5.5
	10	445	6.0
	11	450	6.8
	12	453	7.4
	13	445	7.8
	14	449	8.0
	15	449	8.0
	16	448	7.9
	17	452	7.3
	18	452	6.4
	19	453	5.2
	20	452	4.7
	21	454	4.3
	22	454	4.0
	23	455	3.9
	24	455	3.8
	MONTH	10795	5.4
APRIL	1-Apr	437	3.3
	2	437	3.3
	3	435	3.2
	4	438	3.2
	5	436	3.2
	6	435	3.1
	7	435	3.4
	8	434	4.2
	9	429	5.3
	10	429	6.0
	11	434	6.8
	12	429	7.5
	13	429	7.9
	14	435	8.1
	15	434	8.1
	16	434	8.0
	17	437	7.4
	18	437	6.5
	19	438	5.2
	20	439	4.3
	21	439	3.9
	22	438	3.6
	23	438	3.4
	24	436	3.4
	MONTH	10442	5.1

AVERAGE WIND SPEED (10-M)
WATTS BAR NUCLEAR PLANT
JANUARY 1974 - DECEMBER 1988

MONTH	HOUR	NUMBER OF VALID OBSERVATIONS	MEAN WIND SPEED AT 10-M (mi/h)
MAY	1-May	445	2.3
	2	446	2.3
	3	449	2.3
	4	449	2.2
	5	447	2.2
	6	446	2.3
	7	443	2.3
	8	446	2.9
	9	446	3.9
	10	442	4.7
	11	445	5.4
	12	442	5.9
	13	442	6.3
	14	447	6.7
	15	449	6.7
	16	450	6.6
	17	450	6.4
	18	451	5.8
	19	450	4.8
	20	449	3.6
	21	450	3.0
	22	448	2.7
	23	448	2.5
	24	444	2.4
	MONTH	10724	4.0
JUNE	1-Jun	440	2.1
	2	442	2.1
	3	440	2.0
	4	441	1.9
	5	441	2.0
	6	441	1.9
	7	439	2.0
	8	439	2.8
	9	442	3.8
	10	440	4.5
	11	441	5.0
	12	444	5.4
	13	443	5.9
	14	443	6.2
	15	448	6.3
	16	448	6.2
	17	448	6.1
	18	447	5.7
	19	447	4.7
	20	447	3.7
	21	445	2.9
	22	444	2.5
	23	443	2.4
	24	443	2.2
	MONTH	10636	3.8

AVERAGE WIND SPEED (10-M)
WATTS BAR NUCLEAR PLANT
JANUARY 1974 - DECEMBER 1988

MONTH	HOUR	NUMBER OF VALID OBSERVATIONS	MEAN WIND SPEED AT 10-M (mi/h)
JULY	1-Jul	461	2.0
	2	461	2.0
	3	459	1.9
	4	461	1.9
	5	461	1.9
	6	462	1.9
	7	462	2.0
	8	460	2.6
	9	458	3.5
	10	455	4.2
	11	455	4.7
	12	458	5.0
	13	454	5.4
	14	460	5.5
	15	462	5.6
	16	462	5.7
	17	463	5.3
	18	460	4.9
	19	461	4.2
	20	462	3.2
	21	462	2.6
	22	461	2.4
	23	460	2.1
	24	461	2.1
	MONTH	11041	3.4
AUGUST	1-Aug	456	2.0
	2	457	1.9
	3	458	2.0
	4	449	2.0
	5	448	1.9
	6	445	2.0
	7	443	2.0
	8	445	2.5
	9	450	3.4
	10	446	4.1
	11	455	4.5
	12	453	4.9
	13	455	5.2
	14	456	5.4
	15	455	5.4
	16	459	5.5
	17	461	5.2
	18	461	4.7
	19	462	3.8
	20	460	2.9
	21	458	2.5
	22	458	2.3
	23	459	2.2
	24	454	2.1
	MONTH	10903	3.4

AVERAGE WIND SPEED (10-M)
WATTS BAR NUCLEAR PLANT
JANUARY 1974 - DECEMBER 1988

MONTH	HOUR	NUMBER OF VALID OBSERVATIONS	MEAN WIND SPEED AT 10-M (mi/h)
SEPTEMBER	1-Sep	441	2.3
	2	444	2.3
	3	440	2.2
	4	440	2.3
	5	439	2.3
	6	434	2.4
	7	430	2.5
	8	436	2.8
	9	439	3.6
	10	428	4.4
	11	436	4.8
	12	441	5.2
	13	436	5.5
	14	433	5.7
	15	438	5.8
	16	441	5.8
	17	441	5.5
	18	444	4.9
	19	441	3.7
	20	442	3.0
	21	438	2.8
	22	437	2.5
	23	438	2.4
	24	441	2.4
	MONTH	10518	3.6
OCTOBER	1-Oct	451	2.5
	2	451	2.4
	3	453	2.4
	4	451	2.5
	5	455	2.5
	6	457	2.6
	7	456	2.6
	8	455	2.7
	9	458	3.4
	10	457	4.4
	11	458	5.0
	12	458	5.4
	13	461	5.8
	14	460	6.0
	15	464	6.0
	16	464	5.8
	17	464	5.4
	18	460	4.2
	19	460	3.2
	20	459	2.8
	21	459	2.7
	22	461	2.7
	23	462	2.6
	24	458	2.6
	MONTH	10992	3.7

AVERAGE WIND SPEED (10-M)
WATTS BAR NUCLEAR PLANT
JANUARY 1974 - DECEMBER 1988

MONTH	HOUR	NUMBER OF VALID OBSERVATIONS	MEAN WIND SPEED AT 10-M (mi/h)
NOVEMBER	1-Nov	433	3.2
	2	430	3.1
	3	430	3.2
	4	432	3.3
	5	434	3.3
	6	430	3.4
	7	434	3.3
	8	440	3.5
	9	437	4.3
	10	440	5.1
	11	442	5.6
	12	439	5.8
	13	440	6.1
	14	439	6.0
	15	444	5.8
	16	445	5.4
	17	444	4.4
	18	439	3.7
	19	436	3.4
	20	434	3.4
	21	432	3.2
	22	425	3.3
	23	427	3.2
	24	429	3.3
	MONTH	10455	4.1
DECEMBER	1-Dec	440	3.7
	2	440	3.7
	3	439	3.8
	4	441	3.7
	5	439	3.8
	6	437	3.7
	7	437	3.7
	8	438	3.9
	9	439	4.5
	10	434	5.3
	11	436	5.8
	12	441	6.2
	13	440	6.3
	14	440	6.5
	15	442	6.3
	16	445	5.8
	17	441	4.7
	18	438	4.2
	19		4.0
	20		3.8
	21	440	3.8
	22	439	3.7
	23	438	3.7
	24	438	3.7
	MONTH	10539	4.5

AVERAGE WIND SPEED (10-M)
WATTS BAR NUCLEAR PLANT
JANUARY 1989 - DECEMBER 1993

MONTH	HOUR	NUMBER OF VALID OBSERVATIONS	MEAN WIND SPEED AT 10-M (mi/h)
JANUARY	1-Jan	151	3.2
	2	153	3.2
	3	153	3.2
	4	153	3.2
	5	152	3.2
	6	153	3.3
	7	153	3.3
	8	151	3.3
	9	150	3.9
	10	149	4.7
	11	151	5.0
	12	151	5.3
	13	150	5.6
	14	153	5.7
	15	154	5.4
	16	154	5.0
	17	152	4.2
	18	154	3.4
	19	153	3.3
	20	154	3.3
	21	153	3.1
	22	154	3.1
	23	153	3.1
	24	153	3.2
	MONTH	3657	3.9
FEBRUARY	1-Feb	141	3.5
	2	141	3.6
	3	141	3.7
	4	141	3.6
	5	140	3.5
	6	141	3.7
	7	141	3.6
	8	140	4.0
	9	141	4.8
	10	141	5.4
	11	141	5.6
	12	140	6.0
	13	138	6.3
	14	137	6.7
	15	141	6.7
	16	140	6.4
	17	141	5.8
	18	141	4.7
	19	141	4.0
	20	138	3.8
	21	140	3.8
	22	141	3.8
	23	141	3.6
	24	141	3.6
	MONTH	3369	4.6

AVERAGE WIND SPEED (10-M)
WATTS BAR NUCLEAR PLANT
JANUARY 1989 - DECEMBER 1993

MONTH	HOUR	NUMBER OF VALID OBSERVATIONS	MEAN WIND SPEED AT 10-M (mi/h)
MARCH	1-Mar	149	3.3
	2	148	3.4
	3	147	3.4
	4	145	3.6
	5	146	3.5
	6	147	3.5
	7	146	3.6
	8	144	4.2
	9	147	5.0
	10	149	5.5
	11	150	6.0
	12	150	6.2
	13	151	6.7
	14	150	6.9
	15	151	6.8
	16	151	6.5
	17	151	5.9
	18	148	4.8
	19	149	4.0
	20	147	3.8
	21	147	3.7
	22	147	3.6
	23	145	3.5
	24	146	3.4
	MONTH	3551	4.6
APRIL	1-Apr	140	2.7
	2	142	2.5
	3	142	2.6
	4	143	2.6
	5	143	2.5
	6	142	2.5
	7	144	2.7
	8	142	3.1
	9	144	4.3
	10	145	5.1
	11	144	5.6
	12	146	6.1
	13	145	6.7
	14	146	6.9
	15	147	7.0
	16	147	7.0
	17	147	6.7
	18	146	5.8
	19	146	4.4
	20	144	3.2
	21	144	2.9
	22	142	2.8
	23	143	2.7
	24	140	2.7
	MONTH	3454	4.2

AVERAGE WIND SPEED (10-M)
WATTS BAR NUCLEAR PLANT
JANUARY 1989 - DECEMBER 1993

MONTH	HOUR	NUMBER OF VALID OBSERVATIONS	MEAN WIND SPEED AT 10-M (mi/h)
MAY	1-May	150	1.9
	2	151	1.7
	3	151	1.9
	4	152	1.9
	5	147	1.9
	6	151	1.8
	7	152	1.9
	8	150	2.7
	9	146	3.4
	10	152	4.3
	11	153	4.7
	12	153	5.4
	13	152	5.7
	14	154	5.9
	15	153	5.9
	16	154	5.7
	17	152	5.3
	18	154	4.7
	19	154	3.9
	20	153	3.0
	21	149	2.5
	22	151	2.4
	23	150	2.3
	24	149	2.2
	MONTH	3633	3.5
JUNE	1-Jun	137	1.6
	2	138	1.7
	3	135	1.6
	4	135	1.6
	5	137	1.7
	6	138	1.7
	7	138	1.8
	8	136	2.4
	9	138	3.4
	10	137	4.0
	11	140	4.4
	12	142	4.7
	13	142	5.1
	14	142	5.3
	15	142	5.2
	16	143	5.2
	17	143	4.8
	18	143	4.4
	19	142	3.7
	20	141	2.7
	21	142	2.1
	22	140	1.9
	23	140	1.7
	24	137	1.6
	MONTH	3348	3.1

AVERAGE WIND SPEED (10-M)
WATTS BAR NUCLEAR PLANT
JANUARY 1989 - DECEMBER 1993

MONTH	HOUR	NUMBER OF VALID OBSERVATIONS	MEAN WIND SPEED AT 10-M (mi/h)
JULY	1-Jul	144	1.4
	2	149	1.5
	3	151	1.5
	4	150	1.4
	5	149	1.5
	6	149	1.5
	7	148	1.6
	8	152	2.2
	9	147	3.3
	10	147	3.8
	11	150	4.2
	12	151	4.5
	13	152	4.8
	14	152	5.0
	15	151	5.2
	16	151	5.1
	17	152	4.9
	18	151	4.4
	19	150	3.6
	20	149	2.7
	21	147	2.1
	22	151	1.9
	23	149	1.7
	24	149	1.5
	MONTH	3591	3.0
AUGUST	1-Aug	147	1.4
	2	148	1.4
	3	148	1.3
	4	148	1.4
	5	146	1.4
	6	147	1.4
	7	144	1.4
	8	148	1.9
	9	149	2.9
	10	147	3.5
	11	151	3.8
	12	151	4.1
	13	150	4.5
	14	151	4.7
	15	151	4.6
	16	150	4.7
	17	148	4.4
	18	148	4.1
	19	147	3.3
	20	143	2.3
	21	147	1.8
	22	147	1.6
	23	148	1.4
	24	146	1.4
	MONTH	3550	2.7

AVERAGE WIND SPEED (10-M)
WATTS BAR NUCLEAR PLANT
JANUARY 1989 - DECEMBER 1993

MONTH	HOUR	NUMBER OF VALID OBSERVATIONS	MEAN WIND SPEED AT 10-M (mi/h)
SEPTEMBER	1-Sep	144	1.9
	2	142	1.9
	3	142	1.9
	4	141	2.0
	5	140	1.9
	6	141	2.0
	7	138	2.1
	8	140	2.4
	9	139	3.2
	10	138	4.1
	11	145	4.5
	12	144	4.9
	13	143	5.1
	14	143	5.2
	15	145	5.3
	16	147	5.2
	17	147	4.8
	18	141	4.1
	19	140	2.9
	20	144	2.4
	21	142	2.2
	22	142	2.0
	23	142	1.8
	24	143	1.8
	MONTH	3413	3.2
OCTOBER	1-Oct	148	2.1
	2	151	2.0
	3	145	2.1
	4	145	2.1
	5	144	2.1
	6	144	2.1
	7	142	2.0
	8	136	2.3
	9	143	3.0
	10	149	3.8
	11	153	4.5
	12	153	4.8
	13	153	5.1
	14	153	5.3
	15	152	5.3
	16	153	5.1
	17	152	4.6
	18	152	3.4
	19	150	2.5
	20	150	2.3
	21	148	2.2
	22	148	2.1
	23	148	2.2
	24	150	2.0
	MONTH	3562	3.1

AVERAGE WIND SPEED (10-M)
WATTS BAR NUCLEAR PLANT
JANUARY 1989 - DECEMBER 1993

MONTH	HOUR	NUMBER OF VALID OBSERVATIONS	MEAN WIND SPEED AT 10-M (mi/h)
NOVEMBER	1-Nov	147	2.8
	2	147	2.9
	3	146	2.8
	4	146	2.9
	5	145	3.1
	6	146	3.1
	7	145	3.0
	8	146	3.2
	9	146	4.0
	10	146	4.6
	11	148	5.0
	12	146	5.3
	13	147	5.7
	14	147	5.5
	15	147	5.4
	16	147	4.8
	17	147	3.9
	18	147	3.2
	19	146	2.9
	20	146	2.9
	21	144	2.7
	22	146	2.6
	23	147	2.6
	24	148	2.7
	MONTH	3513	3.7
DECEMBER	1-Dec	153	3.7
	2	154	3.6
	3	154	3.5
	4	154	3.4
	5	155	3.5
	6	153	3.5
	7	152	3.5
	8	154	3.6
	9	153	4.2
	10	153	4.8
	11	154	5.1
	12	155	5.3
	13	155	5.5
	14	155	5.4
	15	155	5.2
	16	154	4.7
	17	154	3.9
	18	152	3.5
	19	152	3.3
	20	152	3.4
	21	153	3.6
	22	152	3.7
	23	150	3.7
	24	148	3.8
	MONTH	3676	4.1

AVERAGE STABILITY CLASS PERCENT FREQUENCY
WATTS BAR NUCLEAR PLANT
JANUARY 1974 - DECEMBER 1988

MONTH	HOUR	A	B	C	D	E	F	G
JANUARY	1	0.0	0.0	0.0	36.0	36.2	19.8	8.1
	2	0.0	0.2	0.0	37.1	37.3	17.5	7.9
	3	0.0	0.2	0.2	38.3	35.1	18.9	7.2
	4	0.0	0.0	0.5	36.7	37.6	19.7	5.4
	5	0.0	0.0	0.0	40.0	36.1	18.7	5.2
	6	0.0	0.0	0.0	39.6	36.0	19.8	4.5
	7	0.2	0.0	0.0	41.4	34.5	19.6	4.3
	8	0.0	0.0	0.2	45.8	38.4	12.5	3.1
	9	0.0	0.4	4.9	63.4	25.8	4.3	1.1
	10	3.0	4.8	14.3	62.1	14.5	1.1	0.2
	11	8.8	10.2	16.7	55.8	7.7	0.7	0.2
	12	6.3	9.9	16.4	59.7	7.0	0.7	0.0
	13	21.9	10.0	18.2	43.7	6.2	0.0	0.0
	14	7.0	7.9	16.4	62.0	6.7	0.0	0.0
	15	4.3	6.5	15.0	68.2	6.0	0.0	0.0
	16	0.9	0.7	6.0	81.5	10.5	0.4	0.0
	17	0.0	0.5	1.6	65.5	31.1	1.4	0.0
	18	0.0	0.0	0.2	42.7	43.2	10.3	3.6
	19	0.0	0.0	0.2	38.1	38.1	15.5	8.1
	20	0.0	0.0	0.0	36.0	36.6	15.5	11.9
	21	0.0	0.0	0.0	36.5	36.0	15.1	12.4
	22	0.0	0.0	0.0	36.0	33.7	17.8	12.6
	23	0.0	0.0	0.0	36.9	32.9	18.2	11.9
	24	0.0	0.0	0.0	37.5	33.7	17.5	11.2
	MONTH	2.2	2.1	4.6	47.5	27.5	11.0	5.0

AVERAGE STABILITY CLASS PERCENT FREQUENCY
WATTS BAR NUCLEAR PLANT
JANUARY 1974 - DECEMBER 1988

MONTH	HOUR	A	B	C	D	E	F	G
FEBRUARY	1	0.0	0.0	0.0	30.6	29.1	21.9	18.4
	2	0.0	0.0	0.0	32.1	29.0	22.5	16.4
	3	0.0	0.0	0.0	31.8	31.0	21.9	15.3
	4	0.0	0.0	0.0	31.0	33.0	22.6	13.5
	5	0.0	0.0	0.0	32.1	33.8	22.9	11.2
	6	0.0	0.0	0.0	33.6	30.3	26.7	9.4
	7	0.0	0.0	0.0	35.5	32.1	24.0	8.4
	8	0.0	0.0	0.0	44.3	36.4	13.7	5.6
	9	0.5	0.8	7.7	62.5	21.9	5.4	1.3
	10	5.4	8.5	16.7	56.8	10.5	1.8	0.3
	11	12.4	15.2	18.4	48.0	5.8	0.3	0.0
	12	9.8	15.2	22.5	49.7	2.3	0.5	0.0
	13	24.5	16.1	17.6	39.3	2.6	0.0	0.0
	14	20.2	14.9	20.2	41.4	3.3	0.0	0.0
	15	9.1	13.7	23.5	49.9	3.8	0.0	0.0
	16	2.5	2.3	12.3	75.6	7.3	0.0	0.0
	17	0.5	0.3	1.5	78.4	19.0	0.3	0.0
	18	0.3	0.0	0.8	45.8	44.0	8.5	0.8
	19	0.0	0.0	0.0	34.9	40.1	14.0	11.0
	20	0.0	0.0	0.0	33.3	32.8	15.0	18.8
	21	0.0	0.0	0.0	32.6	30.1	14.9	22.5
	22	0.0	0.0	0.0	31.8	30.0	16.5	21.6
	23	0.0	0.0	0.0	30.4	30.6	18.5	20.5
	24	0.0	0.0	0.0	30.0	29.2	19.9	20.9
	MONTH	3.6	3.6	5.9	42.1	23.7	12.2	9.0

AVERAGE STABILITY CLASS PERCENT FREQUENCY
WATTS BAR NUCLEAR PLANT
JANUARY 1974 - DECEMBER 1988

MONTH	HOUR	A	B	C	D	E	F	G
MARCH	1	0.0	0.0	0.0	22.1	27.0	24.8	26.1
	2	0.0	0.0	0.0	23.0	29.4	25.2	22.3
	3	0.0	0.0	0.0	22.0	32.2	24.9	20.9
	4	0.0	0.0	0.0	23.2	32.0	26.3	18.5
	5	0.0	0.0	0.0	22.2	35.9	24.8	17.1
	6	0.0	0.0	0.0	23.3	34.4	27.9	14.4
	7	0.0	0.0	0.0	29.7	35.0	25.4	9.8
	8	0.2	0.0	2.7	53.4	32.7	7.9	3.2
	9	2.9	5.8	11.2	62.9	12.1	3.6	1.3
	10	8.1	14.5	18.1	50.0	7.5	1.6	0.2
	11	18.2	14.3	20.0	41.7	5.8	0.0	0.0
	12	14.3	12.9	24.1	45.4	3.3	0.0	0.0
	13	32.5	13.9	17.7	34.1	1.8	0.0	0.0
	14	24.6	15.4	18.5	39.3	1.8	0.4	0.0
	15	12.6	14.2	20.6	49.2	3.1	0.2	0.0
	16	4.2	4.4	20.2	66.0	5.1	0.0	0.0
	17	0.9	0.7	4.2	82.5	11.7	0.0	0.0
	18	0.2	0.0	1.8	49.9	46.8	1.3	0.0
	19	0.0	0.0	0.0	29.7	48.7	15.2	6.4
	20	0.0	0.0	0.0	23.3	41.4	16.1	19.2
	21	0.0	0.0	0.0	22.7	37.0	15.6	24.7
	22	0.0	0.0	0.0	22.6	34.0	14.7	28.7
	23	0.0	0.0	0.0	20.9	31.0	19.1	29.0
	24	0.0	0.0	0.0	19.6	32.4	17.8	30.2
	MONTH	4.9	4.0	6.6	36.6	24.3	12.2	11.3

AVERAGE STABILITY CLASS PERCENT FREQUENCY
WATTS BAR NUCLEAR PLANT
JANUARY 1974 - DECEMBER 1988

MONTH	HOUR	A	B	C	D	E	F	G
APRIL	1	0.0	0.0	0.0	14.3	26.1	24.0	35.6
	2	0.0	0.0	0.0	14.8	25.7	25.9	33.6
	3	0.0	0.0	0.0	14.4	27.1	28.2	30.3
	4	0.0	0.0	0.0	15.3	26.9	30.6	27.2
	5	0.0	0.0	0.0	14.2	30.6	30.6	24.7
	6	0.0	0.0	0.0	16.5	31.6	31.6	20.4
	7	0.0	0.0	0.0	28.5	37.4	21.7	12.3
	8	0.5	0.9	8.3	47.9	32.0	7.4	3.0
	9	6.8	7.3	14.2	60.8	9.9	0.5	0.5
	10	12.0	13.2	19.1	51.1	4.5	0.2	0.0
	11	19.3	14.7	21.9	42.1	2.1	0.0	0.0
	12	19.0	11.7	25.6	41.5	2.1	0.0	0.0
	13	25.1	12.0	25.6	35.2	2.1	0.0	0.0
	14	22.1	15.4	24.4	36.4	1.6	0.0	0.0
	15	11.5	14.7	23.6	47.0	3.2	0.0	0.0
	16	5.1	7.1	16.1	66.8	4.8	0.0	0.0
	17	1.6	2.5	6.4	80.1	9.4	0.0	0.0
	18	0.0	0.9	2.7	56.0	38.0	2.3	0.0
	19	0.0	0.0	0.7	29.7	51.0	14.1	4.5
	20	0.0	0.0	0.0	19.5	44.1	18.0	18.4
	21	0.0	0.0	0.0	14.8	33.9	21.1	30.2
	22	0.0	0.0	0.0	12.7	33.0	17.7	36.6
	23	0.0	0.0	0.0	12.5	31.4	16.6	39.4
	24	0.0	0.0	0.0	13.8	28.1	20.6	37.4
	MONTH	5.1	4.2	7.9	32.7	22.4	13.0	14.8

AVERAGE STABILITY CLASS PERCENT FREQUENCY
WATTS BAR NUCLEAR PLANT
JANUARY 1974 - DECEMBER 1988

MONTH	HOUR	A	B	C	D	E	F	G
MAY	1	0.0	0.0	0.0	7.3	35.5	34.2	23.0
	2	0.0	0.0	0.0	9.0	33.9	38.5	18.5
	3	0.0	0.0	0.0	9.5	35.8	39.1	15.6
	4	0.0	0.0	0.0	9.0	39.1	39.3	12.5
	5	0.0	0.0	0.0	11.5	42.1	37.4	9.0
	6	0.0	0.0	0.0	12.4	44.9	35.2	7.5
	7	0.0	0.0	0.0	21.0	50.2	23.4	5.4
	8	0.0	0.0	1.3	52.4	42.9	3.3	0.0
	9	2.2	5.1	10.7	70.2	11.0	0.7	0.0
	10	7.9	10.9	17.2	60.2	3.8	0.0	0.0
	11	15.8	11.7	23.7	47.0	1.8	0.0	0.0
	12	17.8	15.1	18.7	47.7	0.5	0.2	0.0
	13	14.3	13.1	23.8	47.3	1.6	0.0	0.0
	14	19.2	15.4	21.4	41.4	2.7	0.0	0.0
	15	12.6	11.0	22.2	51.8	2.2	0.2	0.0
	16	7.0	7.5	20.7	60.0	4.6	0.2	0.0
	17	1.7	3.1	14.2	70.7	10.0	0.2	0.0
	18	0.0	0.4	1.8	82.0	15.4	0.4	0.0
	19	0.0	0.0	0.2	50.8	46.8	2.2	0.0
	20	0.0	0.0	0.0	17.4	55.7	22.5	4.4
	21	0.0	0.0	0.0	10.5	40.0	30.1	19.3
	22	0.0	0.0	0.0	8.6	38.4	26.5	26.5
	23	0.0	0.0	0.0	7.9	34.1	30.3	27.7
	24	0.0	0.0	0.0	7.1	34.7	32.7	25.4
	MONTH	4.1	3.9	7.3	33.9	26.2	16.5	8.1

AVERAGE STABILITY CLASS PERCENT FREQUENCY
WATTS BAR NUCLEAR PLANT
JANUARY 1974 - DECEMBER 1988

MONTH	HOUR	A	B	C	D	E	F	G
JUNE	1	0.0	0.0	0.0	6.3	37.8	38.3	17.6
	2	0.0	0.0	0.0	6.3	37.6	43.4	12.8
	3	0.0	0.0	0.0	7.2	41.3	42.0	9.5
	4	0.0	0.0	0.0	7.4	45.5	41.5	5.6
	5	0.0	0.0	0.0	7.0	47.2	41.2	4.7
	6	0.0	0.0	0.0	7.0	54.2	35.7	3.0
	7	0.0	0.0	0.0	18.2	61.8	18.9	1.2
	8	0.0	0.0	0.7	68.5	29.9	0.9	0.0
	9	1.9	5.9	16.5	69.3	6.1	0.2	0.0
	10	10.6	10.4	26.8	51.8	0.5	0.0	0.0
	11	16.9	15.1	23.1	44.5	0.5	0.0	0.0
	12	22.0	17.6	21.3	37.9	1.2	0.0	0.0
	13	19.5	14.6	24.2	40.2	1.4	0.0	0.0
	14	25.8	17.0	22.3	32.3	2.3	0.2	0.0
	15	16.5	15.8	23.5	41.6	2.1	0.2	0.2
	16	9.0	9.2	24.5	53.1	3.5	0.7	0.0
	17	3.9	6.9	15.7	65.4	7.4	0.7	0.0
	18	0.5	1.6	7.2	77.1	13.2	0.2	0.2
	19	0.2	0.0	0.5	59.7	38.0	1.6	0.0
	20	0.0	0.0	0.0	18.3	60.0	20.4	1.4
	21	0.0	0.0	0.0	8.8	44.0	31.5	15.7
	22	0.0	0.0	0.0	7.1	36.6	32.9	23.3
	23	0.0	0.0	0.0	5.7	34.3	35.4	24.6
	24	0.0	0.0	0.0	6.2	36.3	32.9	24.6
	MONTH	5.3	4.8	8.6	31.1	26.8	17.4	6.0

AVERAGE STABILITY CLASS PERCENT FREQUENCY
WATTS BAR NUCLEAR PLANT
JANUARY 1974 - DECEMBER 1988

MONTH	HOUR	A	B	C	D	E	F	G
JULY	1	0.0	0.0	0.0	6.8	42.9	38.6	11.8
	2	0.0	0.0	0.0	6.6	50.4	36.0	7.0
	3	0.0	0.0	0.0	8.1	52.6	33.8	5.5
	4	0.0	0.0	0.0	8.3	53.6	34.6	3.5
	5	0.0	0.0	0.0	10.2	55.3	31.2	3.3
	6	0.2	0.0	0.0	12.2	56.0	29.4	2.2
	7	0.0	0.0	0.0	21.4	62.4	14.7	1.5
	8	0.0	0.2	0.4	65.6	31.1	2.4	0.2
	9	1.3	4.6	18.2	69.9	5.9	0.0	0.0
	10	10.2	9.7	24.6	54.6	0.9	0.0	0.0
	11	15.8	14.2	26.2	42.7	0.9	0.2	0.0
	12	20.4	16.0	26.2	37.5	0.0	0.0	0.0
	13	16.9	12.9	25.6	43.0	1.6	0.0	0.0
	14	20.4	16.2	21.0	39.2	2.6	0.7	0.0
	15	17.3	11.6	21.2	45.7	3.9	0.2	0.0
	16	10.1	11.4	17.5	57.1	3.7	0.2	0.0
	17	3.3	5.4	17.2	69.5	4.6	0.0	0.0
	18	0.7	1.8	6.1	77.6	12.5	1.1	0.2
	19	0.0	0.0	0.2	63.0	33.5	3.1	0.2
	20	0.0	0.0	0.0	21.9	57.3	19.3	1.5
	21	0.0	0.0	0.0	8.1	47.6	29.5	14.8
	22	0.0	0.0	0.0	6.3	39.4	34.9	19.4
	23	0.0	0.0	0.0	6.6	35.4	39.4	18.6
	24	0.0	0.0	0.0	7.2	41.0	35.4	16.4
	MONTH	4.9	4.3	8.5	32.9	29.0	16.0	4.4

AVERAGE STABILITY CLASS PERCENT FREQUENCY
WATTS BAR NUCLEAR PLANT
JANUARY 1974 - DECEMBER 1988

MONTH	HOUR	A	B	C	D	E	F	G
AUGUST	1	0.0	0.0	0.0	7.3	47.5	39.5	5.8
	2	0.0	0.0	0.0	6.6	53.5	36.1	3.8
	3	0.0	0.0	0.0	9.5	58.2	30.1	2.2
	4	0.0	0.0	0.0	10.1	63.2	25.1	1.6
	5	0.0	0.0	0.0	10.8	62.8	25.7	0.7
	6	0.0	0.0	0.0	13.3	63.9	22.3	0.5
	7	0.0	0.0	0.0	17.2	67.0	15.4	0.5
	8	0.2	0.0	0.0	51.2	47.4	1.1	0.0
	9	0.7	1.6	10.6	77.7	9.4	0.0	0.0
	10	9.0	10.6	20.4	57.4	2.5	0.0	0.0
	11	14.4	16.2	26.1	41.7	1.6	0.0	0.0
	12	21.1	15.7	23.6	39.3	0.2	0.0	0.0
	13	16.9	10.6	25.2	46.4	0.7	0.2	0.0
	14	24.1	16.0	23.4	33.3	2.5	0.7	0.0
	15	17.4	11.2	19.2	47.7	4.0	0.4	0.0
	16	9.3	7.3	20.4	58.1	4.0	0.9	0.0
	17	2.4	5.3	12.4	71.0	8.4	0.4	0.0
	18	0.2	0.9	3.1	81.7	13.5	0.4	0.2
	19	0.0	0.0	0.2	43.2	52.2	3.9	0.4
	20	0.0	0.0	0.0	15.1	48.7	30.3	5.9
	21	0.0	0.0	0.0	7.7	40.4	37.8	14.1
	22	0.0	0.0	0.0	5.7	42.6	38.7	13.0
	23	0.0	0.0	0.0	7.0	42.7	39.9	10.4
	24	0.0	0.0	0.0	7.1	44.9	40.3	7.7
	MONTH	4.8	4.0	7.7	31.9	32.6	16.2	2.8

AVERAGE STABILITY CLASS PERCENT FREQUENCY
WATTS BAR NUCLEAR PLANT
JANUARY 1974 - DECEMBER 1988

MONTH	HOUR	A	B	C	D	E	F	G
SEPTEMBER	1	0.0	0.0	0.0	9.3	42.5	42.0	6.2
	2	0.0	0.0	0.0	11.5	44.6	37.9	6.0
	3	0.0	0.0	0.0	12.2	51.3	31.7	4.8
	4	0.0	0.0	0.0	13.3	53.7	29.2	3.9
	5	0.0	0.0	0.0	14.5	54.6	28.7	2.2
	6	0.0	0.0	0.0	15.7	58.4	23.7	2.2
	7	0.0	0.0	0.0	19.3	59.2	21.0	0.5
	8	0.0	0.0	0.0	38.3	56.6	4.9	0.2
	9	1.2	1.7	5.6	74.2	17.4	0.0	0.0
	10	9.2	7.4	17.4	63.0	3.0	0.0	0.0
	11	19.4	12.8	20.6	46.4	0.7	0.0	0.0
	12	19.7	19.9	20.6	38.6	1.2	0.0	0.0
	13	18.2	16.7	24.3	40.3	0.2	0.2	0.0
	14	24.7	15.3	22.5	36.3	1.0	0.2	0.0
	15	17.1	17.8	20.2	42.9	2.0	0.0	0.0
	16	6.8	12.8	16.7	61.0	2.7	0.0	0.0
	17	2.2	3.1	11.7	78.9	4.1	0.0	0.0
	18	0.0	0.0	3.3	69.5	26.9	0.2	0.0
	19	0.0	0.0	0.0	26.9	51.8	19.7	1.7
	20	0.0	0.0	0.0	12.9	43.2	29.4	14.6
	21	0.0	0.0	0.0	12.3	37.7	36.2	13.8
	22	0.0	0.0	0.0	9.9	38.6	36.9	14.7
	23	0.0	0.0	0.0	10.8	37.6	40.0	11.5
	24	0.0	0.0	0.0	9.4	41.6	39.4	9.6
	MONTH	4.9	4.5	6.8	32.0	30.4	17.6	3.8

AVERAGE STABILITY CLASS PERCENT FREQUENCY
WATTS BAR NUCLEAR PLANT
JANUARY 1974 - DECEMBER 1988

MONTH	HOUR	A	B	C	D	E	F	G
OCTOBER	1	0.0	0.0	0.0	15.9	27.9	43.6	12.5
	2	0.0	0.0	0.0	15.8	31.9	41.6	10.7
	3	0.0	0.0	0.0	15.3	31.1	44.3	9.3
	4	0.0	0.0	0.0	15.2	38.1	37.6	9.1
	5	0.0	0.0	0.2	16.2	42.7	33.4	7.4
	6	0.0	0.0	0.0	19.3	42.7	31.1	7.0
	7	0.2	0.0	0.0	18.8	47.0	29.1	4.9
	8	0.0	0.0	0.0	31.3	46.4	20.0	2.3
	9	0.0	0.7	1.9	70.1	24.5	2.8	0.0
	10	5.0	5.7	14.0	68.2	6.6	0.5	0.0
	11	14.0	13.7	24.4	46.3	1.6	0.0	0.0
	12	19.3	13.5	25.1	42.0	0.2	0.0	0.0
	13	18.6	15.8	22.3	43.2	0.2	0.0	0.0
	14	19.4	17.6	25.1	36.8	1.2	0.0	0.0
	15	16.2	14.8	24.8	43.8	0.5	0.0	0.0
	16	4.0	7.7	16.6	70.2	1.6	0.0	0.0
	17	0.0	0.2	2.6	84.0	11.6	1.6	0.0
	18	0.0	0.0	0.0	37.9	55.6	4.2	2.3
	19	0.0	0.0	0.0	15.1	38.5	31.3	15.1
	20	0.0	0.0	0.0	13.5	30.0	28.4	28.1
	21	0.0	0.0	0.0	14.9	25.1	29.1	30.9
	22	0.0	0.0	0.0	13.1	27.5	33.3	26.1
	23	0.0	0.0	0.0	14.8	24.6	39.4	21.1
	24	0.0	0.0	0.0	15.1	25.5	43.2	16.2
	MONTH	4.0	3.7	6.5	32.4	24.3	20.6	8.5

AVERAGE STABILITY CLASS PERCENT FREQUENCY
WATTS BAR NUCLEAR PLANT
JANUARY 1974 - DECEMBER 1988

MONTH	HOUR	A	B	C	D	E	F	G
NOVEMBER	1	0.0	0.0	0.0	22.4	29.3	29.3	19.1
	2	0.0	0.0	0.0	21.7	30.9	31.2	16.2
	3	0.0	0.0	0.0	24.1	32.2	29.4	14.4
	4	0.0	0.0	0.0	22.7	35.5	29.0	12.8
	5	0.0	0.0	0.0	25.4	38.5	25.9	10.3
	6	0.0	0.0	0.0	24.4	40.9	24.7	10.0
	7	0.0	0.0	0.0	26.0	44.2	20.9	8.8
	8	0.0	0.0	0.0	43.5	44.2	10.0	2.3
	9	0.0	1.2	6.5	67.3	22.0	2.6	0.5
	10	4.9	4.7	16.0	63.1	11.0	0.0	0.2
	11	9.2	10.1	17.7	58.1	4.6	0.2	0.0
	12	10.0	10.9	22.0	53.8	2.8	0.5	0.0
	13	10.1	12.4	23.6	51.4	2.5	0.0	0.0
	14	3.3	8.8	18.1	67.9	1.9	0.0	0.0
	15	0.5	2.8	8.1	85.0	3.5	0.2	0.0
	16	0.0	0.0	1.4	85.4	13.3	0.0	0.0
	17	0.0	0.0	0.0	33.5	56.5	10.0	0.0
	18	0.0	0.0	0.0	22.7	39.9	23.4	14.0
	19	0.0	0.0	0.0	21.3	33.4	19.5	25.9
	20	0.0	0.0	0.0	22.2	29.1	19.3	29.4
	21	0.0	0.0	0.0	20.9	31.3	20.9	26.9
	22	0.0	0.0	0.0	21.1	32.6	20.0	26.2
	23	0.0	0.0	0.0	22.6	30.6	24.2	22.6
	24	0.0	0.0	0.0	21.1	30.6	30.6	17.7
	MONTH	1.6	2.1	4.7	38.7	26.7	15.5	10.7

AVERAGE STABILITY CLASS PERCENT FREQUENCY
WATTS BAR NUCLEAR PLANT
JANUARY 1974 - DECEMBER 1988

MONTH	HOUR	A	B	C	D	E	F	G
DECEMBER	1	0.2	0.0	0.0	27.8	32.6	26.5	12.9
	2	0.0	0.0	0.0	27.7	35.5	23.8	13.0
	3	0.0	0.0	0.0	29.1	36.8	22.0	12.1
	4	0.0	0.0	0.2	30.8	35.3	23.0	10.7
	5	0.0	0.0	0.0	32.3	35.2	23.1	9.4
	6	0.0	0.0	0.0	32.0	38.2	21.6	8.3
	7	0.0	0.0	0.0	32.7	36.4	23.1	7.8
	8	0.2	0.0	0.0	40.1	40.1	15.7	3.9
	9	0.2	0.9	2.1	64.1	28.1	3.2	1.4
	10	2.6	2.8	14.6	64.9	14.6	0.5	0.0
	11	7.0	7.7	24.7	53.6	7.0	0.0	0.0
	12	8.2	8.2	25.0	54.8	3.9	0.0	0.0
	13	13.5	13.0	23.5	47.0	3.0	0.0	0.0
	14	4.1	5.7	17.4	70.3	2.3	0.2	0.0
	15	2.5	4.5	12.2	77.2	3.4	0.2	0.0
	16	0.2	0.2	1.6	87.8	9.9	0.2	0.0
	17	0.0	0.2	0.0	41.8	51.9	6.1	0.0
	18	0.0	0.0	0.2	27.3	42.7	19.6	10.2
	19	0.2	0.0	0.0	27.1	35.0	21.2	16.5
	20	0.2	0.0	0.0	27.9	32.9	20.0	18.9
	21	0.0	0.2	0.0	28.6	32.2	21.1	17.9
	22	0.0	0.0	0.0	26.1	32.0	25.0	16.9
	23	0.0	0.0	0.0	26.1	34.2	23.0	16.7
	24	0.0	0.0	0.0	27.4	34.2	23.1	15.2
	MONTH	1.6	1.8	5.1	41.9	27.4	14.3	8.0

AVERAGE STABILITY CLASS PERCENT FREQUENCY
WATTS BAR NUCLEAR PLANT
JANUARY 1989 - DECEMBER 1993

MONTH	HOUR	A	B	C	D	E	F	G
JANUARY	1	0.0	0.0	0.0	32.5	30.5	21.2	15.9
	2	0.0	0.0	0.0	34.9	27.6	25.7	11.8
	3	0.0	0.0	0.0	36.2	32.2	20.4	11.2
	4	0.0	0.0	0.0	35.5	30.9	25.0	8.6
	5	0.0	0.0	0.0	36.2	30.9	23.0	9.9
	6	0.0	0.0	0.0	35.5	34.9	26.3	3.3
	7	0.0	0.0	0.0	38.2	35.5	20.4	5.9
	8	0.0	0.0	0.0	44.7	38.7	14.0	2.7
	9	0.0	0.7	1.3	70.5	24.2	2.0	1.3
	10	2.7	4.7	11.5	74.3	6.1	0.7	0.0
	11	11.4	8.1	16.8	60.4	3.4	0.0	0.0
	12	9.3	8.6	26.5	53.6	2.0	0.0	0.0
	13	19.5	14.1	12.8	52.3	1.3	0.0	0.0
	14	5.3	9.9	12.5	69.1	3.3	0.0	0.0
	15	7.2	7.2	15.8	63.8	5.9	0.0	0.0
	16	0.0	0.0	2.0	90.1	7.9	0.0	0.0
	17	0.0	0.0	0.0	59.5	39.9	0.7	0.0
	18	0.0	0.0	0.0	32.0	39.9	20.9	7.2
	19	0.0	0.0	0.0	31.6	32.9	16.4	19.1
	20	0.0	0.0	0.0	30.7	31.4	12.4	25.5
	21	0.0	0.0	0.0	28.8	28.1	15.0	28.1
	22	0.0	0.0	0.0	30.1	26.8	18.3	24.8
	23	0.0	0.0	0.0	28.8	28.8	21.6	20.9
	24	0.0	0.0	0.0	32.0	28.1	19.0	20.9
	MONTH	2.3	2.2	4.1	45.9	23.8	12.6	9.0

AVERAGE STABILITY CLASS PERCENT FREQUENCY
WATTS BAR NUCLEAR PLANT
JANUARY 1989 - DECEMBER 1993

MONTH	HOUR	A	B	C	D	E	F	G
FEBRUARY	1	0.0	0.0	0.0	31.1	26.7	20.0	22.2
	2	0.0	0.0	0.0	29.6	28.9	22.2	19.3
	3	0.0	0.0	0.0	37.5	23.5	22.1	16.9
	4	0.0	0.0	0.0	34.1	30.4	20.0	15.6
	5	0.0	0.0	0.0	32.6	34.1	18.5	14.8
	6	0.0	0.0	0.0	35.6	30.4	21.5	12.6
	7	0.0	0.0	0.0	37.0	31.9	20.7	10.4
	8	0.0	0.0	0.8	46.6	31.6	15.0	6.0
	9	1.5	5.3	4.5	66.2	20.3	1.5	0.8
	10	7.5	8.2	15.7	63.4	5.2	0.0	0.0
	11	16.3	15.6	11.9	51.9	4.4	0.0	0.0
	12	15.7	11.9	21.6	46.3	4.5	0.0	0.0
	13	30.3	15.2	8.3	43.9	2.3	0.0	0.0
	14	14.3	18.0	11.3	51.1	5.3	0.0	0.0
	15	13.3	8.9	17.0	56.3	4.4	0.0	0.0
	16	3.7	6.7	9.6	73.3	6.7	0.0	0.0
	17	0.0	0.0	0.7	72.1	26.5	0.7	0.0
	18	0.0	0.0	0.0	40.0	42.2	15.6	2.2
	19	0.0	0.0	0.0	32.6	30.4	16.3	20.7
	20	0.0	0.0	0.0	31.1	31.9	12.6	24.4
	21	0.0	0.0	0.0	32.6	27.4	13.3	26.7
	22	0.0	0.0	0.0	31.9	25.2	14.1	28.9
	23	0.0	0.0	0.0	30.4	25.2	15.6	28.9
	24	0.0	0.0	0.0	27.6	29.1	20.1	23.1
	MONTH	4.3	3.7	4.2	43.1	22.0	11.2	11.4

AVERAGE STABILITY CLASS PERCENT FREQUENCY
WATTS BAR NUCLEAR PLANT
JANUARY 1989 - DECEMBER 1993

MONTH	HOUR	A	B	C	D	E	F	G
MARCH	1	0.0	0.0	0.0	27.0	27.0	23.0	23.0
	2	0.0	0.0	0.0	25.2	29.3	22.4	23.1
	3	0.0	0.0	0.0	26.7	29.5	23.3	20.5
	4	0.0	0.0	0.0	29.7	31.0	22.8	16.6
	5	0.0	0.0	0.0	29.0	32.4	22.8	15.9
	6	0.0	0.0	0.0	30.3	30.3	28.3	11.0
	7	0.0	0.0	0.0	36.6	31.7	25.5	6.2
	8	0.0	0.0	2.1	65.2	25.5	6.4	0.7
	9	2.2	10.1	16.5	64.7	5.0	1.4	0.0
	10	13.4	16.2	16.9	50.0	2.8	0.7	0.0
	11	24.1	20.7	11.0	42.1	2.1	0.0	0.0
	12	25.5	15.9	13.1	43.4	2.1	0.0	0.0
	13	42.7	11.9	9.1	34.3	2.1	0.0	0.0
	14	28.5	13.9	16.7	41.0	0.0	0.0	0.0
	15	17.9	14.5	14.5	51.7	1.4	0.0	0.0
	16	4.8	5.5	15.9	69.0	4.8	0.0	0.0
	17	0.0	0.0	2.0	85.0	12.9	0.0	0.0
	18	0.0	0.0	0.0	41.5	55.1	3.4	0.0
	19	0.0	0.0	0.0	26.4	43.9	17.6	12.2
	20	0.0	0.0	0.0	25.3	34.9	15.8	24.0
	21	0.0	0.0	0.0	26.0	27.4	13.7	32.9
	22	0.0	0.0	0.0	23.3	28.8	14.4	33.6
	23	0.0	0.0	0.0	22.8	33.1	10.3	33.8
	24	0.0	0.0	0.0	24.8	27.6	18.6	29.0
	MONTH	6.6	4.5	4.9	39.2	21.7	11.3	11.8

AVERAGE STABILITY CLASS PERCENT FREQUENCY
WATTS BAR NUCLEAR PLANT
JANUARY 1989 - DECEMBER 1993

MONTH	HOUR	A	B	C	D	E	F	G
APRIL	1	0.0	0.0	0.0	15.0	29.3	21.1	34.6
	2	0.0	0.0	0.0	14.8	26.7	26.7	31.9
	3	0.0	0.0	0.0	12.6	32.6	25.9	28.9
	4	0.0	0.0	0.0	11.8	33.1	29.4	25.7
	5	0.0	0.0	0.0	12.5	34.6	33.8	19.1
	6	0.0	0.0	0.0	12.6	38.5	31.1	17.8
	7	0.0	0.0	0.0	16.8	40.1	34.3	8.8
	8	0.0	0.7	0.7	40.7	43.0	11.1	3.7
	9	3.7	1.5	7.4	76.5	10.3	0.7	0.0
	10	6.5	16.7	17.4	57.2	2.2	0.0	0.0
	11	14.6	16.1	19.7	49.6	0.0	0.0	0.0
	12	22.3	15.8	21.6	38.1	2.2	0.0	0.0
	13	16.4	13.6	21.4	47.9	0.7	0.0	0.0
	14	25.2	15.1	15.1	41.7	2.9	0.0	0.0
	15	24.8	9.9	14.9	46.8	3.5	0.0	0.0
	16	16.3	9.2	12.8	56.7	4.3	0.7	0.0
	17	7.1	6.4	7.1	71.4	7.1	0.7	0.0
	18	0.0	0.0	2.9	74.1	23.0	0.0	0.0
	19	0.0	0.0	0.0	34.5	59.7	2.9	2.9
	20	0.0	0.0	0.0	14.5	50.7	23.2	11.6
	21	0.0	0.0	0.0	13.9	29.9	26.3	29.9
	22	0.0	0.0	0.0	14.1	27.4	24.4	34.1
	23	0.0	0.0	0.0	18.4	23.5	20.6	37.5
	24	0.0	0.0	0.0	14.3	30.1	16.5	39.1
	MONTH	5.7	4.4	5.9	33.6	23.1	13.7	13.6

AVERAGE STABILITY CLASS PERCENT FREQUENCY
WATTS BAR NUCLEAR PLANT
JANUARY 1989 - DECEMBER 1993

MONTH	HOUR	A	B	C	D	E	F	G
MAY	1	0.0	0.0	0.0	9.3	36.4	37.1	17.2
	2	0.0	0.0	0.0	7.2	36.6	41.8	14.4
	3	0.0	0.0	0.0	9.2	39.5	41.4	9.9
	4	0.0	0.0	0.0	10.5	42.5	39.9	7.2
	5	0.0	0.0	0.0	10.7	45.0	34.9	9.4
	6	0.0	0.0	0.0	15.0	39.2	37.9	7.8
	7	0.0	0.0	0.0	17.6	54.2	26.1	2.0
	8	0.0	0.0	0.0	61.6	36.4	1.3	0.7
	9	0.7	4.8	9.5	73.5	10.9	0.7	0.0
	10	8.6	11.3	24.5	51.0	4.0	0.7	0.0
	11	22.2	17.6	17.0	41.2	2.0	0.0	0.0
	12	25.5	19.0	18.3	36.6	0.7	0.0	0.0
	13	19.0	18.3	16.3	46.4	0.0	0.0	0.0
	14	18.8	17.5	21.4	40.9	1.3	0.0	0.0
	15	17.5	12.3	23.4	44.8	1.9	0.0	0.0
	16	7.1	9.0	22.6	56.1	5.2	0.0	0.0
	17	1.3	3.9	9.2	79.1	6.5	0.0	0.0
	18	0.0	0.6	2.6	78.1	18.1	0.6	0.0
	19	0.0	0.0	0.0	40.6	58.7	0.6	0.0
	20	0.0	0.0	0.0	15.6	53.2	24.7	6.5
	21	0.0	0.0	0.0	9.3	43.7	23.2	23.8
	22	0.0	0.0	0.0	9.2	38.6	25.5	26.8
	23	0.0	0.0	0.0	11.1	35.3	25.5	28.1
	24	0.0	0.0	0.0	10.6	34.4	27.8	27.2
	MONTH	5.0	4.8	6.9	32.7	26.8	16.2	7.5

AVERAGE STABILITY CLASS PERCENT FREQUENCY
WATTS BAR NUCLEAR PLANT
JANUARY 1989 - DECEMBER 1993

MONTH	HOUR	A	B	C	D	E	F	G
JUNE	1	0.0	0.0	0.0	4.2	43.8	43.1	9.0
	2	0.0	0.0	0.0	3.4	45.5	46.2	4.8
	3	0.0	0.0	0.0	6.5	44.6	44.6	4.3
	4	0.0	0.0	0.0	5.8	52.9	36.2	5.1
	5	0.0	0.0	0.0	7.0	59.2	29.6	4.2
	6	0.0	0.0	0.0	8.3	53.1	36.6	2.1
	7	0.0	0.0	0.0	15.9	68.3	15.2	0.7
	8	0.0	0.0	1.4	63.4	34.5	0.7	0.0
	9	4.1	5.5	11.7	71.7	6.9	0.0	0.0
	10	13.4	12.0	18.3	55.6	0.7	0.0	0.0
	11	22.6	15.1	19.2	43.2	0.0	0.0	0.0
	12	24.0	18.5	15.8	40.4	1.4	0.0	0.0
	13	24.0	13.0	21.2	40.4	1.4	0.0	0.0
	14	26.7	13.0	15.8	41.8	2.1	0.7	0.0
	15	17.8	16.4	11.6	48.6	5.5	0.0	0.0
	16	15.0	6.8	18.4	55.1	4.8	0.0	0.0
	17	6.1	8.8	8.1	68.2	8.8	0.0	0.0
	18	0.0	0.0	4.1	77.7	17.6	0.0	0.7
	19	0.0	0.0	0.0	51.7	44.2	4.1	0.0
	20	0.0	0.0	0.0	12.9	61.2	23.1	2.7
	21	0.0	0.0	0.0	5.4	42.3	36.9	15.4
	22	0.0	0.0	0.0	4.1	36.5	32.4	27.0
	23	0.0	0.0	0.0	2.7	40.4	36.3	20.5
	24	0.0	0.0	0.0	1.4	41.4	36.6	20.7
	MONTH	6.4	4.5	6.1	30.6	29.9	17.6	4.9

AVERAGE STABILITY CLASS PERCENT FREQUENCY
WATTS BAR NUCLEAR PLANT
JANUARY 1989 - DECEMBER 1993

MONTH	HOUR	A	B	C	D	E	F	G
JULY	1	0.0	0.0	0.0	2.0	42.6	41.9	13.5
	2	0.0	0.0	0.0	1.3	50.7	39.5	8.6
	3	0.0	0.0	0.0	2.6	53.2	39.0	5.2
	4	0.0	0.0	0.0	5.3	53.9	37.5	3.3
	5	0.0	0.0	0.0	4.6	60.5	31.6	3.3
	6	0.0	0.0	0.0	4.6	62.5	29.6	3.3
	7	0.0	0.0	0.0	14.5	65.1	19.1	1.3
	8	0.0	0.7	0.0	58.8	39.9	0.7	0.0
	9	2.7	7.4	14.9	71.6	3.4	0.0	0.0
	10	20.5	14.6	15.9	49.0	0.0	0.0	0.0
	11	27.8	19.9	17.9	33.8	0.7	0.0	0.0
	12	36.8	13.8	15.8	31.6	2.0	0.0	0.0
	13	28.1	13.7	15.7	41.8	0.7	0.0	0.0
	14	35.5	14.5	15.8	31.6	1.3	1.3	0.0
	15	28.3	10.5	19.7	36.8	3.9	0.7	0.0
	16	15.8	11.2	17.8	49.3	5.3	0.7	0.0
	17	7.2	7.2	9.8	69.9	5.2	0.0	0.7
	18	2.0	3.3	1.3	77.6	15.8	0.0	0.0
	19	0.0	0.0	0.7	49.3	48.0	1.3	0.7
	20	0.0	0.0	0.0	10.5	60.5	27.6	1.3
	21	0.0	0.0	0.0	3.9	42.8	35.5	17.8
	22	0.0	0.0	0.0	1.9	38.3	39.6	20.1
	23	0.0	0.0	0.0	2.6	41.1	35.8	20.5
	24	0.0	0.0	0.0	2.0	43.0	41.7	13.2
	MONTH	8.5	4.9	6.1	27.4	30.9	17.6	4.7

AVERAGE STABILITY CLASS PERCENT FREQUENCY
WATTS BAR NUCLEAR PLANT
JANUARY 1989 - DECEMBER 1993

MONTH	HOUR	A	B	C	D	E	F	G
AUGUST	1	0.0	0.0	0.0	2.7	45.0	47.0	5.4
	2	0.0	0.0	0.0	2.7	52.7	41.2	3.4
	3	0.0	0.0	0.0	5.4	54.1	40.5	0.0
	4	0.0	0.0	0.0	4.1	62.8	32.4	0.7
	5	0.0	0.0	0.0	4.7	68.9	26.4	0.0
	6	0.0	0.0	0.0	3.4	70.3	26.4	0.0
	7	0.0	0.0	0.0	7.4	77.0	15.5	0.0
	8	0.0	0.0	0.0	36.2	63.8	0.0	0.0
	9	2.7	0.7	4.7	84.0	8.0	0.0	0.0
	10	14.9	14.9	12.8	55.4	2.0	0.0	0.0
	11	21.9	19.2	21.9	36.4	0.7	0.0	0.0
	12	28.0	20.0	16.7	35.3	0.0	0.0	0.0
	13	16.0	21.3	18.0	43.3	1.3	0.0	0.0
	14	25.2	19.9	19.2	34.4	1.3	0.0	0.0
	15	17.9	21.2	17.2	35.8	7.3	0.7	0.0
	16	10.7	15.3	17.3	50.7	6.0	0.0	0.0
	17	1.3	2.0	10.7	77.9	8.1	0.0	0.0
	18	0.0	1.3	0.7	81.2	16.8	0.0	0.0
	19	0.0	0.0	0.0	34.0	55.3	10.0	0.7
	20	0.0	0.0	0.0	8.7	43.6	35.6	12.1
	21	0.0	0.0	0.0	6.1	32.4	41.2	20.3
	22	0.0	0.0	0.0	5.4	31.1	42.6	20.9
	23	0.0	0.0	0.0	3.4	29.7	53.4	13.5
	24	0.0	0.0	0.0	2.0	39.5	51.0	7.5
	MONTH	5.8	5.7	5.8	27.5	32.4	19.3	3.5

AVERAGE STABILITY CLASS PERCENT FREQUENCY
WATTS BAR NUCLEAR PLANT
JANUARY 1989 - DECEMBER 1993

MONTH	HOUR	A	B	C	D	E	F	G
SEPTEMBER	1	0.0	0.0	0.0	8.9	45.9	39.7	5.5
	2	0.0	0.0	0.0	11.1	45.8	38.9	4.2
	3	0.0	0.0	0.0	11.1	50.7	34.7	3.5
	4	0.0	0.0	0.0	11.1	56.9	30.6	1.4
	5	0.0	0.0	0.0	12.5	61.8	25.7	0.0
	6	0.0	0.0	0.0	11.8	63.9	23.6	0.7
	7	0.0	0.0	0.0	15.3	68.1	16.7	0.0
	8	0.0	0.0	0.0	34.0	62.5	3.5	0.0
	9	0.7	1.4	4.3	80.1	13.5	0.0	0.0
	10	9.9	7.0	14.8	66.9	1.4	0.0	0.0
	11	19.4	13.2	25.7	41.0	0.7	0.0	0.0
	12	27.8	9.0	22.9	38.9	1.4	0.0	0.0
	13	21.0	12.6	23.8	42.7	0.0	0.0	0.0
	14	25.9	14.7	17.5	41.3	0.7	0.0	0.0
	15	22.1	13.1	15.9	47.6	1.4	0.0	0.0
	16	6.1	11.6	15.6	61.9	4.8	0.0	0.0
	17	0.7	0.7	6.8	86.4	5.4	0.0	0.0
	18	0.0	0.0	0.0	66.4	32.9	0.7	0.0
	19	0.0	0.0	0.0	21.5	52.1	22.2	4.2
	20	0.0	0.0	0.0	11.0	38.6	29.7	20.7
	21	0.0	0.0	0.0	9.0	40.7	26.2	24.1
	22	0.0	0.0	0.0	7.6	40.7	35.2	16.6
	23	0.0	0.0	0.0	8.3	39.3	40.0	12.4
	24	0.0	0.0	0.0	8.3	39.3	44.1	8.3
	MONTH	5.6	3.5	6.1	31.4	32.0	17.1	4.2

AVERAGE STABILITY CLASS PERCENT FREQUENCY
WATTS BAR NUCLEAR PLANT
JANUARY 1989 - DECEMBER 1993

MONTH	HOUR	A	B	C	D	E	F	G
OCTOBER	1	0.0	0.0	0.0	12.3	26.6	49.4	11.7
	2	0.0	0.0	0.0	12.9	27.1	50.3	9.7
	3	0.0	0.0	0.0	12.3	34.2	43.9	9.7
	4	0.0	0.0	0.0	12.3	40.6	41.3	5.8
	5	0.0	0.0	0.0	15.5	43.9	36.8	3.9
	6	0.0	0.0	0.0	15.5	42.6	38.1	3.9
	7	0.0	0.0	0.0	16.8	48.4	32.3	2.6
	8	0.0	0.0	0.0	23.9	57.4	15.5	3.2
	9	0.0	1.3	1.9	70.1	26.0	0.0	0.6
	10	3.3	6.5	13.1	71.9	5.2	0.0	0.0
	11	25.8	13.2	17.9	42.4	0.7	0.0	0.0
	12	29.6	17.8	14.5	36.8	1.3	0.0	0.0
	13	17.6	22.2	19.6	40.5	0.0	0.0	0.0
	14	20.9	20.9	19.6	38.6	0.0	0.0	0.0
	15	22.2	12.4	17.0	46.4	2.0	0.0	0.0
	16	5.9	7.2	18.3	67.3	1.3	0.0	0.0
	17	0.0	0.0	2.0	85.0	11.1	2.0	0.0
	18	0.0	0.0	0.0	31.4	54.9	11.1	2.6
	19	0.0	0.0	0.0	13.1	30.1	32.7	24.2
	20	0.0	0.0	0.0	14.4	23.5	24.8	37.3
	21	0.0	0.0	0.0	11.8	24.8	29.4	34.0
	22	0.0	0.0	0.0	9.2	26.1	37.9	26.8
	23	0.0	0.0	0.0	13.1	24.8	44.4	17.6
	24	0.0	0.0	0.0	13.7	24.2	44.4	17.6
	MONTH	5.2	4.2	5.2	30.3	24.0	22.3	8.8

AVERAGE STABILITY CLASS PERCENT FREQUENCY
WATTS BAR NUCLEAR PLANT
JANUARY 1989 - DECEMBER 1993

MONTH	HOUR	A	B	C	D	E	F	G
NOVEMBER	1	0.0	0.0	0.0	18.2	27.0	32.4	22.3
	2	0.0	0.0	0.0	18.2	31.8	29.7	20.3
	3	0.0	0.0	0.0	20.3	31.8	24.3	23.6
	4	0.0	0.0	0.0	20.3	34.5	27.0	18.2
	5	0.0	0.0	0.0	22.4	36.7	25.2	15.6
	6	0.0	0.0	0.0	25.0	37.8	26.4	10.8
	7	0.0	0.0	0.0	26.5	38.8	22.4	12.2
	8	0.0	0.0	0.0	45.0	41.6	9.4	4.0
	9	0.7	2.1	5.6	71.5	20.1	0.0	0.0
	10	9.0	7.6	13.2	62.5	7.6	0.0	0.0
	11	13.3	13.3	14.7	54.5	4.2	0.0	0.0
	12	9.2	12.0	18.3	58.5	2.1	0.0	0.0
	13	16.2	13.4	16.2	53.5	0.7	0.0	0.0
	14	8.3	10.4	13.9	65.3	2.1	0.0	0.0
	15	2.1	4.1	11.0	78.8	4.1	0.0	0.0
	16	0.0	0.0	0.7	87.1	12.2	0.0	0.0
	17	0.0	0.0	0.0	29.1	58.1	12.8	0.0
	18	0.0	0.0	0.0	17.6	41.2	22.3	18.9
	19	0.0	0.0	0.0	12.8	41.2	20.9	25.0
	20	0.0	0.0	0.0	15.5	33.8	23.6	27.0
	21	0.0	0.0	0.0	16.2	28.4	27.0	28.4
	22	0.0	0.0	0.0	18.2	27.0	28.4	26.4
	23	0.0	0.0	0.0	18.9	26.4	33.1	21.6
	24	0.0	0.0	0.0	17.6	27.7	33.8	20.9
	MONTH	2.5	2.6	3.9	36.4	25.7	16.6	12.3

AVERAGE STABILITY CLASS PERCENT FREQUENCY
WATTS BAR NUCLEAR PLANT
JANUARY 1989 - DECEMBER 1993

MONTH	HOUR	A	B	C	D	E	F	G
DECEMBER	1	0.0	0.0	0.0	40.0	32.3	19.4	8.4
	2	0.0	0.0	0.0	36.1	32.9	23.2	7.7
	3	0.0	0.0	0.0	38.1	36.1	20.6	5.2
	4	0.0	0.0	0.0	39.4	32.3	23.2	5.2
	5	0.0	0.0	0.0	38.1	38.7	16.1	7.1
	6	0.0	0.0	0.0	41.9	35.5	16.1	6.5
	7	0.0	0.0	0.0	40.6	33.5	20.6	5.2
	8	0.0	0.0	0.0	48.4	35.5	14.2	1.9
	9	0.0	0.0	1.3	70.1	25.3	3.2	0.0
	10	1.3	5.2	9.2	71.9	11.8	0.7	0.0
	11	7.1	7.8	17.5	61.0	6.5	0.0	0.0
	12	3.9	6.5	16.2	68.2	5.2	0.0	0.0
	13	14.9	9.1	16.9	53.2	5.8	0.0	0.0
	14	3.2	3.9	14.3	74.7	3.9	0.0	0.0
	15	2.6	7.1	9.0	76.8	3.9	0.6	0.0
	16	0.0	0.0	0.0	89.7	9.7	0.6	0.0
	17	0.0	0.0	0.0	46.8	46.8	5.8	0.6
	18	0.0	0.0	0.0	36.4	38.3	17.5	7.8
	19	0.0	0.0	0.0	33.1	33.1	20.1	13.6
	20	0.0	0.0	0.0	35.1	31.2	16.2	17.5
	21	0.0	0.0	0.0	33.1	36.4	18.2	12.3
	22	0.0	0.0	0.0	33.8	37.0	20.8	8.4
	23	0.0	0.0	0.0	37.3	32.7	20.3	9.8
	24	0.0	0.0	0.0	38.2	34.9	19.1	7.9
	MONTH	1.4	1.7	3.5	49.3	26.6	12.4	5.2

Calm Occurrence (%) By Year For Watts Bar Nuclear Plant

Year	WBN 10-m	WBN 46-m
1974	0.7	
1975	0.4	
1976	1.6	
1977	0.0	0.1
1978	0.1	0.1
1979	0.4	0.2
1980	0.8	1.0
1981	1.9	0.7
1982	1.2	0.8
1983	2.0	1.0
1984	1.0	1.4
1985	2.6	2.3
1986	2.1	3.0
1987	3.8	2.7
1988	5.2	2.4
1989	5.6	2.9
1990	7.1	4.5
1991	3.4	2.9
1992	5.9	3.0
1993	13.2	5.6

Calms are wind speeds of less than 0.6 mi/h.

10/24/94
CALMS.XLS

ATTACHMENT

Question 17

FREQUENCY DISTRIBUTION DATE PRINTED 26-OCT-94

KNOXVILLE, TENNESSEE JAN 1, 92-DEC31, 92

SPEED (MPH)
(KTS)

DIRECTION	0-3 0-3	4-7 4-6	8-12 7-10	13-18 11-16	19-24 17-21	GREATER THAN 24 GREATER THAN 21	TOTAL
N	0.001	0.001	0.000	0.000	0.000	0.000	0.002
NNE	0.001	0.001	0.000	0.000	0.000	0.000	0.002
NE	0.001	0.001	0.000	0.000	0.000	0.000	0.001
ENE	0.000	0.001	0.000	0.000	0.000	0.000	0.002
E	0.000	0.001	0.000	0.000	0.000	0.000	0.001
ESE	0.000	0.000	0.000	0.000	0.000	0.000	0.001
SE	0.000	0.000	0.000	0.000	0.000	0.000	0.001
SSE	0.000	0.000	0.000	0.000	0.000	0.000	0.001
S	0.000	0.001	0.000	0.000	0.000	0.000	0.001
SSW	0.000	0.000	0.000	0.000	0.000	0.000	0.001
SW	0.001	0.001	0.000	0.000	0.000	0.000	0.002
WSW	0.000	0.001	0.000	0.000	0.000	0.000	0.001
W	0.000	0.001	0.000	0.000	0.000	0.000	0.002
WNW	0.000	0.001	0.000	0.000	0.000	0.000	0.001
NW	0.001	0.002	0.000	0.000	0.000	0.000	0.002
NNW	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	0.007	0.014	0.000	0.000	0.000	0.000	

FREQUENCY OF OCCURRENCE OF A STABILITY = 0.021

FREQUENCY OF CALMS DISTRIBUTED ABOVE WITH A STABILITY = 0.004

NOTE-STAR PROGRAM

FREQUENCY DISTRIBUTION DATE PRINTED 26-OCT-94

KNOXVILLE, TENNESSEE JAN 1, 92-DEC31, 92

SPEED (MPH)
(KTS)

DIRECTION	0-3 0-3	4-7 4-6	8-12 7-10	13-18 11-16	19-24 17-21	GREATER THAN 24 GREATER THAN 21	TOTAL
N	0.004	0.004	0.001	0.000	0.000	0.000	0.009
NNE	0.002	0.003	0.000	0.000	0.000	0.000	0.005
NE	0.003	0.007	0.001	0.000	0.000	0.000	0.011
ENE	0.003	0.005	0.002	0.000	0.000	0.000	0.009
E	0.002	0.002	0.001	0.000	0.000	0.000	0.004
ESE	0.002	0.002	0.000	0.000	0.000	0.000	0.004
SE	0.001	0.001	0.000	0.000	0.000	0.000	0.002
SSE	0.000	0.001	0.000	0.000	0.000	0.000	0.001
S	0.003	0.002	0.001	0.000	0.000	0.000	0.006
SSW	0.002	0.003	0.001	0.000	0.000	0.000	0.006
SW	0.002	0.007	0.003	0.000	0.000	0.000	0.012
WSW	0.002	0.005	0.004	0.000	0.000	0.000	0.010
W	0.002	0.004	0.001	0.000	0.000	0.000	0.007
WNW	0.002	0.003	0.001	0.000	0.000	0.000	0.006
NW	0.001	0.003	0.000	0.000	0.000	0.000	0.005
NNW	0.002	0.002	0.000	0.000	0.000	0.000	0.004
TOTAL	0.030	0.054	0.016	0.000	0.000	0.000	

FREQUENCY OF OCCURRENCE OF B STABILITY = 0.100

FREQUENCY OF CALMS DISTRIBUTED ABOVE WITH B STABILITY = 0.010

NOTE-STAR PROGRAM

FREQUENCY DISTRIBUTION DATE PRINTED 26-OCT-94

KNOXVILLE, TENNESSEE JAN 1, 92-DEC31, 92

SPEED (MPH)
(KTS)

DIRECTION	0-3 0-3	4-7 4-6	8-12 7-10	13-18 11-16	19-24 17-21	GREATER THAN 24 GREATER THAN 21	TOTAL
N	0.002	0.007	0.002	0.000	0.000	0.000	0.011
NNE	0.001	0.003	0.001	0.000	0.000	0.000	0.005
NE	0.002	0.005	0.004	0.000	0.000	0.000	0.011
ENE	0.002	0.006	0.004	0.000	0.000	0.000	0.013
E	0.001	0.003	0.001	0.000	0.000	0.000	0.005
ESE	0.001	0.001	0.000	0.000	0.000	0.000	0.002
SE	0.000	0.001	0.000	0.000	0.000	0.000	0.001
SSE	0.000	0.002	0.000	0.000	0.000	0.000	0.002
S	0.001	0.003	0.001	0.000	0.000	0.000	0.005
SSW	0.001	0.003	0.003	0.000	0.000	0.000	0.007
SW	0.001	0.006	0.011	0.002	0.000	0.000	0.019
WSW	0.001	0.006	0.010	0.001	0.000	0.000	0.017
W	0.001	0.005	0.003	0.000	0.000	0.000	0.009
WNW	0.001	0.003	0.001	0.000	0.000	0.000	0.005
NW	0.001	0.004	0.001	0.000	0.000	0.000	0.006
NNW	0.001	0.003	0.001	0.000	0.000	0.000	0.004
TOTAL	0.017	0.060	0.042	0.003	0.000	0.000	

FREQUENCY OF OCCURRENCE OF C STABILITY = 0.122

FREQUENCY OF CALMS DISTRIBUTED ABOVE WITH C STABILITY = 0.008

NOTE-STAR PROGRAM

FREQUENCY DISTRIBUTION DATE PRINTED 26-OCT-94

KNOXVILLE, TENNESSEE JAN 1, 92-DEC31, 92

SPEED (MPH)
(KTS)

DIRECTION	0-3 0-3	4-7 4-6	8-12 7-10	13-18 11-16	19-24 17-21	GREATER THAN 24 GREATER THAN 21	TOTAL
N	0.013	0.024	0.006	0.000	0.000	0.000	0.043
NNE	0.005	0.014	0.004	0.000	0.000	0.000	0.023
NE	0.007	0.021	0.008	0.000	0.000	0.000	0.036
ENE	0.005	0.017	0.006	0.002	0.000	0.000	0.029
E	0.003	0.006	0.002	0.000	0.000	0.000	0.011
ESE	0.001	0.002	0.001	0.000	0.000	0.000	0.004
SE	0.001	0.002	0.000	0.001	0.000	0.000	0.003
SSE	0.001	0.002	0.001	0.001	0.000	0.000	0.005
S	0.002	0.004	0.002	0.002	0.000	0.000	0.010
SSW	0.002	0.006	0.004	0.002	0.000	0.000	0.015
SW	0.003	0.011	0.018	0.008	0.000	0.000	0.041
WSW	0.005	0.018	0.015	0.005	0.000	0.000	0.043
W	0.006	0.017	0.007	0.001	0.000	0.000	0.030
WNW	0.003	0.009	0.005	0.001	0.000	0.000	0.018
NW	0.005	0.010	0.002	0.000	0.000	0.000	0.017
NNW	0.007	0.016	0.002	0.000	0.000	0.000	0.025
TOTAL	0.068655	0.17921	0.08266	0.022544	0.001025	0.000455	

FREQUENCY OF OCCURRENCE OF D STABILITY = 0.355

FREQUENCY OF CALMS DISTRIBUTED ABOVE WITH D STABILITY = 0.030

NOTE-STAR PROGRAM

FREQUENCY DISTRIBUTION DATE PRINTED 26-OCT-94

KNOXVILLE, TENNESSEE JAN 1, 92-DEC31, 92

SPEED (MPH)
(KTS)

DIRECTION	0-3 0-3	4-7 4-6	8-12 7-10	13-18 11-16	19-24 17-21	GREATER THAN 24 GREATER THAN 21	TOTAL
N	0.000	0.013	0.002	0.000	0.000	0.000	0.014
NNE	0.000	0.006	0.001	0.000	0.000	0.000	0.007
NE	0.000	0.009	0.001	0.000	0.000	0.000	0.010
ENE	0.000	0.005	0.000	0.000	0.000	0.000	0.005
E	0.000	0.003	0.000	0.000	0.000	0.000	0.003
ESE	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SE	0.000	0.001	0.000	0.000	0.000	0.000	0.001
SSE	0.000	0.001	0.000	0.000	0.000	0.000	0.001
S	0.000	0.002	0.001	0.000	0.000	0.000	0.003
SSW	0.000	0.004	0.002	0.000	0.000	0.000	0.006
SW	0.000	0.009	0.006	0.000	0.000	0.000	0.015
WSW	0.000	0.008	0.004	0.000	0.000	0.000	0.012
W	0.000	0.007	0.002	0.000	0.000	0.000	0.008
WNW	0.000	0.004	0.001	0.000	0.000	0.000	0.005
NW	0.000	0.005	0.000	0.000	0.000	0.000	0.005
NNW	0.000	0.003	0.000	0.000	0.000	0.000	0.003
TOTAL	0.000	0.079	0.020	0.000	0.000	0.000	

FREQUENCY OF OCCURRENCE OF E STABILITY = 0.099

FREQUENCY OF CALMS DISTRIBUTED ABOVE WITH E STABILITY = 0.000

NOTE-STAR PROGRAM

FREQUENCY DISTRIBUTION DATE PRINTED 26-OCT-94

KNOXVILLE, TENNESSEE JAN 1, 92-DEC31, 92

SPEED (MPH)
(KTS)

DIRECTION	0-3 0-3	4-7 4-6	8-12 7-10	13-18 11-16	19-24 17-21	GREATER THAN 24 GREATER THAN 21	TOTAL
N	0.011	0.019	0.000	0.000	0.000	0.000	0.029
NNE	0.005	0.012	0.000	0.000	0.000	0.000	0.017
NE	0.007	0.015	0.000	0.000	0.000	0.000	0.021
ENE	0.005	0.007	0.000	0.000	0.000	0.000	0.012
E	0.003	0.004	0.000	0.000	0.000	0.000	0.006
ESE	0.001	0.001	0.000	0.000	0.000	0.000	0.003
SE	0.001	0.001	0.000	0.000	0.000	0.000	0.002
SSE	0.000	0.001	0.000	0.000	0.000	0.000	0.001
S	0.002	0.004	0.000	0.000	0.000	0.000	0.005
SSW	0.003	0.008	0.000	0.000	0.000	0.000	0.011
SW	0.005	0.012	0.000	0.000	0.000	0.000	0.018
WSW	0.005	0.012	0.000	0.000	0.000	0.000	0.017
W	0.005	0.010	0.000	0.000	0.000	0.000	0.015
WNW	0.002	0.004	0.000	0.000	0.000	0.000	0.006
NW	0.004	0.004	0.000	0.000	0.000	0.000	0.008
NNW	0.003	0.003	0.000	0.000	0.000	0.000	0.007
TOTAL	0.062	0.116	0.000	0.000	0.000	0.000	

FREQUENCY OF OCCURRENCE OF F STABILITY = 0.178

FREQUENCY OF CALMS DISTRIBUTED ABOVE WITH F STABILITY = 0.033

NOTE-STAR PROGRAM

FREQUENCY DISTRIBUTION DATE PRINTED 26-OCT-94

KNOXVILLE, TENNESSEE JAN 1, 92-DEC31, 92

SPEED (MPH)
(KTS)

DIRECTION	0-3 0-3	4-7 4-6	8-12 7-10	13-18 11-16	19-24 17-21	GREATER THAN 24 GREATER THAN 21	TOTAL
N	0.017	0.000	0.000	0.000	0.000	0.000	0.017
NNE	0.006	0.000	0.000	0.000	0.000	0.000	0.006
NE	0.016	0.000	0.000	0.000	0.000	0.000	0.016
ENE	0.015	0.000	0.000	0.000	0.000	0.000	0.015
E	0.008	0.000	0.000	0.000	0.000	0.000	0.008
ESE	0.003	0.000	0.000	0.000	0.000	0.000	0.003
SE	0.001	0.000	0.000	0.000	0.000	0.000	0.001
SSE	0.001	0.000	0.000	0.000	0.000	0.000	0.001
S	0.004	0.000	0.000	0.000	0.000	0.000	0.004
SSW	0.006	0.000	0.000	0.000	0.000	0.000	0.006
SW	0.009	0.000	0.000	0.000	0.000	0.000	0.009
WSW	0.008	0.000	0.000	0.000	0.000	0.000	0.008
W	0.010	0.000	0.000	0.000	0.000	0.000	0.010
WNW	0.007	0.000	0.000	0.000	0.000	0.000	0.007
NW	0.006	0.000	0.000	0.000	0.000	0.000	0.006
NNW	0.008	0.000	0.000	0.000	0.000	0.000	0.008
TOTAL	0.126	0.000	0.000	0.000	0.000	0.000	

FREQUENCY OF OCCURRENCE OF G STABILITY = 0.126

FREQUENCY OF CALMS DISTRIBUTED ABOVE WITH G STABILITY = 0.075

NOTE-STAR PROGRAM

FREQUENCY DISTRIBUTION OF WIND SPEED
FOR ALL WIND DIRECTIONS

DATE PRINTED 26-OCT-94

KNOXVILLE, TENNESSEE JAN 1, 92 - DEC 31, 92

SPEED (MPH)
(KTS)

DIRECTION	0-3 0-3	4-7 4-6	8-12 7-10	13-18 11-16	19-24 17-21	GREATER THAN 24 GREATER THAN 21	TOTAL
N	0.048	0.067	0.010	0.000	0.000	0.000	0.126
NNE	0.020	0.040	0.006	0.000	0.000	0.000	0.066
NE	0.035	0.058	0.013	0.000	0.000	0.000	0.106
ENE	0.031	0.041	0.011	0.002	0.000	0.000	0.085
E	0.016	0.018	0.004	0.000	0.000	0.000	0.038
ESE	0.008	0.007	0.001	0.000	0.000	0.000	0.016
SE	0.005	0.005	0.000	0.001	0.000	0.000	0.010
SSE	0.003	0.007	0.002	0.001	0.000	0.000	0.013
S	0.011	0.016	0.004	0.003	0.000	0.000	0.033
SSW	0.014	0.025	0.010	0.002	0.000	0.000	0.051
SW	0.021	0.046	0.038	0.009	0.000	0.000	0.115
WSW	0.020	0.049	0.033	0.006	0.000	0.000	0.108
W	0.024	0.043	0.013	0.001	0.000	0.000	0.081
WNW	0.016	0.024	0.008	0.001	0.000	0.000	0.048
NW	0.017	0.028	0.004	0.000	0.000	0.000	0.049
NNW	0.022	0.027	0.003	0.000	0.000	0.000	0.053
TOTAL	0.311	0.502	0.160	0.026	0.001	0.000	

FREQUENCY OF CALMS DISTRIBUTED ABOVE (ALL STABILITY CLASSES) = 0.159

NOTE-STAR PROGRAM

KNOXVILLE, TENNESSEE JAN 1, 92 - DEC 31, 92 DATE PRINTED 26-OCT-94

NUMBER OF 1 KT (1 MPH) WINDS = 0

NUMBER OF 2 KT (2 MPH) WINDS = 1

NUMBER OF 3 KT (3 MPH) WINDS = 1328

AVERAGE WIND SPEED DURING JAN, 92 WAS 5.1 KTS OR 5.8 MPH

AVERAGE WIND SPEED DURING FEB, 92 WAS 5.0 KTS OR 5.7 MPH

AVERAGE WIND SPEED DURING MAR, 92 WAS 5.2 KTS OR 6.0 MPH

AVERAGE WIND SPEED DURING APR, 92 WAS 5.4 KTS OR 6.3 MPH

AVERAGE WIND SPEED DURING MAY, 92 WAS 4.2 KTS OR 4.9 MPH

AVERAGE WIND SPEED DURING JUN, 92 WAS 4.3 KTS OR 4.9 MPH

AVERAGE WIND SPEED DURING JUL, 92 WAS 4.8 KTS OR 5.6 MPH

AVERAGE WIND SPEED DURING AUG, 92 WAS 3.5 KTS OR 4.1 MPH

AVERAGE WIND SPEED DURING SEP, 92 WAS 3.8 KTS OR 4.4 MPH

AVERAGE WIND SPEED DURING OCT, 92 WAS 3.9 KTS OR 4.5 MPH

AVERAGE WIND SPEED DURING NOV, 92 WAS 4.4 KTS OR 5.1 MPH

AVERAGE WIND SPEED DURING DEC, 92 WAS 4.2 KTS OR 4.9 MPH

AVERAGE WIND SPEED DURING THE PERIOD FROM JAN 1, 92 TO DEC 31, 92 WAS 4.5 KTS OR 5.2 MPH

PRGORAM HAS FINISHED

JOINT PERCENTAGE FREQUENCIES OF WIND SPEED BY WIND DIRECTION FOR

STABILITY CLASS A (DELTA T<=-1.9 C/ 100 M)

WATTS BAR NUCLEAR PLANT

JAN 1, 92 - DEC 31, 92

WIND DIRECTION	WIND SPEED (MPH) CALM	0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	>=24.5	TOTAL
N	0.000	0.000	0.000	0.024	0.036	0.012	0.000	0.000	0.000	0.071
NNE	0.000	0.000	0.024	0.024	0.000	0.024	0.000	0.000	0.000	0.071
NE	0.000	0.000	0.024	0.083	0.083	0.012	0.000	0.000	0.000	0.202
ENE	0.000	0.000	0.047	0.059	0.012	0.012	0.000	0.000	0.000	0.131
E	0.000	0.000	0.024	0.012	0.000	0.000	0.000	0.000	0.000	0.036
ESE	0.000	0.000	0.000	0.012	0.012	0.000	0.000	0.000	0.000	0.024
SE	0.000	0.000	0.000	0.012	0.012	0.000	0.000	0.000	0.000	0.024
SSE	0.000	0.000	0.071	0.036	0.012	0.012	0.000	0.000	0.000	0.131
S	0.000	0.000	0.047	0.142	0.107	0.024	0.000	0.000	0.000	0.320
SSW	0.000	0.000	0.059	0.534	0.546	0.605	0.012	0.000	0.000	1.756
SW	0.000	0.000	0.000	0.119	0.107	0.024	0.012	0.000	0.000	0.261
WSW	0.000	0.000	0.000	0.000	0.012	0.036	0.024	0.000	0.000	0.071
W	0.000	0.000	0.000	0.000	0.000	0.024	0.000	0.000	0.000	0.024
WNW	0.000	0.000	0.012	0.000	0.000	0.059	0.000	0.000	0.000	0.071
NW	0.000	0.000	0.000	0.000	0.000	0.071	0.000	0.000	0.000	0.071
NNW	0.000	0.000	0.000	0.012	0.000	0.012	0.000	0.000	0.000	0.024
SUBTOTAL	0.000	0.000	0.309	1.068	0.938	0.926	0.047	0.000	0.000	3.287

TOTAL HOURS OF VALID STABILITY OBSERVATIONS	8688
TOTAL HOURS OF STABILITY CLASS A	283
TOTAL HOURS OF VALID WIND DIRECTION-WIND SPEED-STABILITY CLASS A	277
TOTAL HOURS OF VALID WIND DIRECTION-WIND SPEED-STABILITY OBSERVATIONS	8426
TOTAL HOURS CALM	0

METEOROLOGICAL FACILITY: WATTS BAR NUCLEAR PLANT
STABILITY BASED ON DELTA-T BETWEEN 9.51 AND 45.63 METERS
WIND SPEED AND DIRECTION MEASURED AT 9.72 METER LEVEL

MEAN WIND SPEED = 6.43

DATE PRINTED: 25-OCT-94

NOTE: TOTALS AND SUBTOTALS ARE OBTAINED FROM UNROUNDED NUMBERS

JOINT PERCENTAGE FREQUENCIES OF WIND SPEED BY WIND DIRECTION FOR

STABILITY CLASS B (-1.9< DELTA T< 1.7 C/100 M

WATTS BAR NUCLEAR PLANT

JAN 1, 92 - DEC 31, 92

WIND DIRECTION	WIND SPEED (MPH) CALM	0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	>=24.5	TOTAL
N	0.000	0.000	0.012	0.095	0.071	0.083	0.000	0.000	0.000	0.261
NNE	0.000	0.000	0.024	0.107	0.059	0.131	0.012	0.000	0.000	0.332
NE	0.000	0.000	0.071	0.178	0.047	0.059	0.000	0.000	0.000	0.356
ENE	0.000	0.000	0.059	0.131	0.036	0.012	0.000	0.000	0.000	0.237
E	0.000	0.000	0.083	0.036	0.012	0.000	0.000	0.000	0.000	0.131
ESE	0.000	0.000	0.047	0.012	0.000	0.000	0.000	0.000	0.000	0.059
SE	0.000	0.000	0.059	0.024	0.000	0.000	0.000	0.000	0.000	0.083
SSE	0.000	0.000	0.059	0.036	0.000	0.012	0.000	0.000	0.000	0.107
S	0.000	0.000	0.071	0.237	0.059	0.012	0.000	0.000	0.000	0.380
SSW	0.000	0.000	0.119	0.415	0.225	0.202	0.024	0.000	0.000	0.985
SW	0.000	0.000	0.059	0.214	0.012	0.024	0.000	0.000	0.000	0.309
WSW	0.000	0.000	0.000	0.059	0.000	0.000	0.000	0.000	0.000	0.059
W	0.000	0.000	0.000	0.000	0.000	0.012	0.000	0.000	0.000	0.012
WNW	0.000	0.000	0.000	0.000	0.047	0.083	0.000	0.000	0.000	0.131
NW	0.000	0.000	0.012	0.024	0.059	0.095	0.000	0.000	0.000	0.190
NNW	0.000	0.000	0.012	0.012	0.024	0.059	0.024	0.000	0.000	0.131
SUBTOTAL	0.000	0.000	0.688	1.578	0.653	0.783	0.059	0.000	0.000	3.762

TOTAL HOURS OF VALID STABILITY OBSERVATIONS	8688
TOTAL HOURS OF STABILITY CLASS B	325
TOTAL HOURS OF VALID WIND DIRECTION-WIND SPEED-STABILITY CLASS B	317
TOTAL HOURS OF VALID WIND DIRECTION-WIND SPEED-STABILITY OBSERVATIONS	8426
TOTAL HOURS CALM	0

METEOROLOGICAL FACILITY: WATTS BAR NUCLEAR PLANT
STABILITY BASED ON DELTA-T BETWEEN 9.51 AND 45.63 METERS
WIND SPEED AND DIRECTION MEASURED AT 9.72 METER LEVEL

DATE PRINTED: 25-OCT-94

MEAN WIND SPEED = 5.63

NOTE: TOTALS AND SUBTOTALS ARE OBTAINED FROM UNROUNDED NUMBERS

JOINT PERCENTAGE FREQUENCIES OF WIND SPEED BY WIND DIRECTION FOR

STABILITY CLASS C (-1.7< DELTA T< 1.5 C/100)

WATTS BAR NUCLEAR PLANT

JAN 1, 92 - DEC 31, 92

WIND DIRECTION	WIND SPEED (MPH) CALM	0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	>=24.5	TOTAL
N	0.000	0.000	0.059	0.131	0.107	0.119	0.000	0.000	0.000	0.415
NNE	0.000	0.000	0.083	0.249	0.214	0.309	0.024	0.000	0.000	0.878
NE	0.000	0.012	0.107	0.309	0.142	0.107	0.000	0.000	0.000	0.676
ENE	0.000	0.000	0.154	0.178	0.024	0.000	0.000	0.000	0.000	0.356
E	0.000	0.000	0.036	0.036	0.012	0.000	0.000	0.000	0.000	0.083
ESE	0.000	0.012	0.047	0.012	0.012	0.000	0.000	0.000	0.000	0.083
SE	0.000	0.000	0.059	0.012	0.000	0.000	0.000	0.000	0.000	0.071
SSE	0.000	0.000	0.059	0.012	0.000	0.024	0.012	0.000	0.000	0.107
S	0.000	0.000	0.166	0.202	0.083	0.012	0.000	0.000	0.000	0.463
SSW	0.000	0.000	0.166	0.297	0.214	0.178	0.024	0.000	0.000	0.878
SW	0.000	0.000	0.095	0.249	0.036	0.000	0.000	0.000	0.000	0.380
WSW	0.000	0.000	0.000	0.059	0.036	0.000	0.000	0.000	0.000	0.095
W	0.000	0.000	0.012	0.000	0.047	0.047	0.000	0.000	0.000	0.107
WNW	0.000	0.000	0.000	0.012	0.012	0.059	0.059	0.000	0.000	0.142
NW	0.000	0.000	0.012	0.012	0.047	0.154	0.012	0.000	0.000	0.237
NNW	0.000	0.000	0.024	0.059	0.059	0.083	0.000	0.000	0.000	0.225
SUBTOTAL	0.000	0.024	1.080	1.828	1.044	1.092	0.131	0.000	0.000	5.198

TOTAL HOURS OF VALID STABILITY OBSERVATIONS	8688
TOTAL HOURS OF STABILITY CLASS C	451
TOTAL HOURS OF VALID WIND DIRECTION-WIND SPEED-STABILITY CLASS C	438
TOTAL HOURS OF VALID WIND DIRECTION-WIND SPEED-STABILITY OBSERVATIONS	8426
TOTAL HOURS CALM	0

METEOROLOGICAL FACILITY: WATTS BAR NUCLEAR PLANT
STABILITY BASED ON DELTA-T BETWEEN 9.51 AND 45.63 METERS
WIND SPEED AND DIRECTION MEASURED AT 9.72 METER LEVEL

DATE PRINTED: 25-OCT-94

MEAN WIND SPEED = 5.75

NOTE: TOTALS AND SUBTOTALS ARE OBTAINED FROM UNROUNDED NUMBERS

JOINT PERCENTAGE FREQUENCIES OF WIND SPEED BY WIND DIRECTION FOR

STABILITY CLASS D (-1.5< DELTA T< 0.5 C/100)

WATTS BAR NUCLEAR PLANT

JAN 1, 92 - DEC 31, 92

WIND DIRECTION	WIND SPEED (MPH) CALM	0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	>=24.5	TOTAL
N	0.014	0.107	0.771	0.997	1.472	1.282	0.036	0.000	0.000	4.678
NNE	0.014	0.059	0.843	1.282	1.329	1.745	0.083	0.000	0.000	5.355
NE	0.021	0.166	1.116	1.389	0.653	0.392	0.000	0.000	0.000	3.735
ENE	0.022	0.178	1.222	0.546	0.107	0.083	0.000	0.000	0.000	2.159
E	0.010	0.225	0.392	0.119	0.012	0.000	0.000	0.000	0.000	0.758
ESE	0.007	0.154	0.309	0.036	0.012	0.000	0.000	0.000	0.000	0.518
SE	0.007	0.131	0.332	0.012	0.036	0.012	0.000	0.000	0.000	0.530
SSE	0.010	0.142	0.498	0.202	0.012	0.059	0.036	0.000	0.000	0.960
S	0.025	0.273	1.294	0.724	0.380	0.107	0.071	0.000	0.000	2.873
SSW	0.032	0.154	1.875	2.267	0.985	0.795	0.036	0.000	0.000	6.145
SW	0.025	0.261	1.329	0.914	0.214	0.071	0.012	0.000	0.000	2.826
WSW	0.011	0.154	0.558	0.237	0.142	0.024	0.000	0.000	0.000	1.127
W	0.010	0.237	0.392	0.320	0.166	0.249	0.012	0.000	0.000	1.387
WNW	0.007	0.083	0.368	0.475	0.546	0.617	0.024	0.000	0.000	2.120
NW	0.008	0.071	0.427	0.439	0.593	0.949	0.036	0.012	0.000	2.536
NNW	0.011	0.047	0.665	0.914	0.783	0.831	0.024	0.000	0.000	3.275
SUBTOTAL	0.237	2.445	12.390	10.871	7.441	7.216	0.368	0.012	0.000	40.980

TOTAL HOURS OF VALID STABILITY OBSERVATIONS	8688
TOTAL HOURS OF STABILITY CLASS D	3534
TOTAL HOURS OF VALID WIND DIRECTION-WIND SPEED-STABILITY CLASS D	3453
TOTAL HOURS OF VALID WIND DIRECTION-WIND SPEED-STABILITY OBSERVATIONS	8426
TOTAL HOURS CALM	20

METEOROLOGICAL FACILITY: WATTS BAR NUCLEAR PLANT
STABILITY BASED ON DELTA-T BETWEEN 9.51 AND 45.63 METERS
WIND SPEED AND DIRECTION MEASURED AT 9.72 METER LEVEL

DATE PRINTED: 25-OCT-94

MEAN WIND SPEED = 4.86

NOTE: TOTALS AND SUBTOTALS ARE OBTAINED FROM UNROUNDED NUMBERS

JOINT PERCENTAGE FREQUENCIES OF WIND SPEED BY WIND DIRECTION FOR

STABILITY CLASS E (-0.5< DELTA T< 1.5 C/100)

WATTS BAR NUCLEAR PLANT

JAN 1, 92 - DEC 31, 92

WIND DIRECTION	WIND SPEED (MPH) CALM	0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	>=24.5	TOTAL
N	0.065	0.142	0.475	0.463	0.225	0.024	0.000	0.000	0.000	1.394
NNE	0.075	0.131	0.582	0.285	0.190	0.012	0.000	0.000	0.000	1.273
NE	0.112	0.297	0.771	0.392	0.083	0.012	0.000	0.000	0.000	1.667
ENE	0.161	0.510	1.021	0.131	0.000	0.000	0.000	0.000	0.000	1.822
E	0.054	0.297	0.214	0.012	0.000	0.000	0.000	0.000	0.000	0.576
ESE	0.024	0.107	0.119	0.000	0.000	0.000	0.000	0.000	0.000	0.249
SE	0.027	0.178	0.083	0.071	0.024	0.012	0.012	0.000	0.000	0.407
SSE	0.071	0.522	0.154	0.142	0.071	0.012	0.012	0.000	0.000	0.985
S	0.176	0.617	1.056	0.297	0.131	0.047	0.036	0.012	0.000	2.371
SSW	0.248	0.665	1.697	0.783	0.534	0.297	0.000	0.000	0.000	4.224
SW	0.218	1.044	1.033	0.225	0.083	0.119	0.000	0.000	0.000	2.722
WSW	0.169	1.033	0.582	0.166	0.059	0.024	0.000	0.000	0.000	2.033
W	0.143	0.760	0.605	0.214	0.154	0.071	0.000	0.000	0.000	1.947
WNW	0.128	0.653	0.570	0.249	0.059	0.059	0.012	0.000	0.000	1.730
NW	0.098	0.475	0.463	0.261	0.083	0.000	0.000	0.000	0.000	1.380
NNW	0.083	0.356	0.439	0.273	0.107	0.036	0.000	0.000	0.000	1.294
SUBTOTAL	1.851	7.785	9.862	3.964	1.804	0.724	0.071	0.012	0.000	26.074

TOTAL HOURS OF VALID STABILITY OBSERVATIONS	8688
TOTAL HOURS OF STABILITY CLASS E	2291
TOTAL HOURS OF VALID WIND DIRECTION-WIND SPEED-STABILITY CLASS E	2197
TOTAL HOURS OF VALID WIND DIRECTION-WIND SPEED-STABILITY OBSERVATIONS	8426
TOTAL HOURS CALM	156

METEOROLOGICAL FACILITY: WATTS BAR NUCLEAR PLANT
STABILITY BASED ON DELTA-T BETWEEN 9.51 AND 45.63 METERS
WIND SPEED AND DIRECTION MEASURED AT 9.72 METER LEVEL

DATE PRINTED: 25-OCT-94

MEAN WIND SPEED = 2.59

NOTE: TOTALS AND SUBTOTALS ARE OBTAINED FROM UNROUNDED NUMBERS

JOINT PERCENTAGE FREQUENCIES OF WIND SPEED BY WIND DIRECTION FOR

STABILITYCLASS F (1.5< DELTA T< 4.0 C/100)

WATTS BAR NUCLEAR PLANT

JAN 1, 92 - DEC 31, 92

WIND DIRECTION	WIND SPEED (MPH) CALM	0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	>=24.5	TOTAL
N	0.105	0.297	0.154	0.000	0.000	0.000	0.000	0.000	0.000	0.556
NNE	0.124	0.320	0.214	0.000	0.000	0.000	0.000	0.000	0.000	0.658
NE	0.121	0.261	0.261	0.071	0.000	0.000	0.000	0.000	0.000	0.715
ENE	0.149	0.344	0.297	0.059	0.000	0.000	0.000	0.000	0.000	0.849
E	0.080	0.237	0.107	0.000	0.000	0.000	0.000	0.000	0.000	0.424
ESE	0.025	0.071	0.036	0.000	0.000	0.000	0.000	0.000	0.000	0.132
SE	0.028	0.083	0.036	0.000	0.000	0.000	0.000	0.000	0.000	0.146
SSE	0.052	0.142	0.083	0.000	0.000	0.000	0.000	0.000	0.000	0.278
S	0.105	0.309	0.142	0.036	0.000	0.000	0.000	0.000	0.000	0.591
SSW	0.163	0.392	0.309	0.012	0.000	0.000	0.000	0.000	0.000	0.875
SW	0.262	0.676	0.451	0.000	0.000	0.000	0.000	0.000	0.000	1.389
WSW	0.400	1.127	0.593	0.000	0.000	0.000	0.000	0.000	0.000	2.121
W	0.279	0.878	0.320	0.012	0.000	0.000	0.000	0.000	0.000	1.489
WNW	0.281	0.914	0.297	0.036	0.000	0.000	0.000	0.000	0.000	1.527
NW	0.298	1.009	0.273	0.036	0.000	0.000	0.000	0.000	0.000	1.615
NNW	0.152	0.415	0.237	0.000	0.000	0.000	0.000	0.000	0.000	0.804
SUBTOTAL	2.623	7.477	3.810	0.261	0.000	0.000	0.000	0.000	0.000	14.170

TOTAL HOURS OF VALID STABILITY OBSERVATIONS	8688
TOTAL HOURS OF STABILITY CLASS F	1235
TOTAL HOURS OF VALID WIND DIRECTION-WIND SPEED-STABILITY CLASS F	1194
TOTAL HOURS OF VALID WIND DIRECTION-WIND SPEED-STABILITY OBSERVATIONS	8426
TOTAL HOURS CALM	221

METEOROLOGICAL FACILITY: WATTS BAR NUCLEAR PLANT
STABILITY BASED ON DELTA-T BETWEEN 9.51 AND 45.63 METERS
WIND SPEED AND DIRECTION MEASURED AT 9.72 METER LEVEL

MEAN WIND SPEED = 1.19

DATE PRINTED: 25-OCT-94

NOTE: TOTALS AND SUBTOTALS ARE OBTAINED FROM UNROUNDED NUMBERS

JOINT PERCENTAGE FREQUENCIES OF WIND SPEED BY WIND DIRECTION FOR

STABILITY CLASS G (DELTA T > 4.0 C/ 100 M)

WATTS BAR NUCLEAR PLANT

JAN 1, 92 - DEC 31, 92

WIND DIRECTION	WIND SPEED (MPH) CALM	0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	>=24.5	TOTAL
N	0.04	0.12	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.21
NNE	0.05	0.18	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.28
NE	0.09	0.24	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.44
ENE	0.11	0.25	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.54
E	0.03	0.08	0.06	0.01	0.00	0.00	0.00	0.00	0.00	0.19
ESE	0.03	0.07	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.13
SE	0.03	0.10	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.13
SSE	0.02	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12
S	0.05	0.20	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.28
SSW	0.07	0.23	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.34
SW	0.11	0.34	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.59
WSW	0.16	0.48	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.82
W	0.17	0.55	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.90
WNW	0.12	0.42	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.62
NW	0.13	0.36	0.19	0.01	0.00	0.00	0.00	0.00	0.00	0.69
NNW	0.05	0.15	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.25
SUBTOTAL	1.26	3.85	1.40	0.02	0.00	0.00	0.00	0.00	0.00	6.53

TOTAL HOURS OF VALID STABILITY OBSERVATIONS	8688
TOTAL HOURS OF STABILITY CLASS G	569
TOTAL HOURS OF VALID WIND DIRECTION-WIND SPEED-STABILITY CLASS G	550
TOTAL HOURS OF VALID WIND DIRECTION-WIND SPEED-STABILITY OBSERVATIONS	8426
TOTAL HOURS CALM	106

METEOROLOGICAL FACILITY: WATTS BAR NUCLEAR PLANT
STABILITY BASED ON DELTA-T BETWEEN 9.51 AND 45.63 METERS
WIND SPEED AND DIRECTION MEASURED AT 9.72 METER LEVEL

DATE PRINTED: 25-OCT-94

MEAN WIND SPEED = 1.04

NOTE: TOTALS AND SUBTOTALS ARE OBTAINED FROM UNROUNDED NUMBERS

JOINT PERCENTAGE FREQUENCIES OF WIND SPEED

BY WIND DIRECTION DISREGARDING STABILITY CLASS

WATTS BAR NUCLEAR PLANT

JAN 1, 92 - DEC 31, 92

WIND DIRECTION	WIND SPEED (MPH) CALM	0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	>=24.5	TOTAL
N	0.255	0.664	1.518	1.707	1.909	1.518	0.036	0.000	0.000	7.606
NNE	0.292	0.688	1.814	1.945	1.790	2.217	0.119	0.000	0.000	8.864
NE	0.401	0.972	2.466	2.419	1.008	0.581	0.000	0.000	0.000	7.847
ENE	0.500	1.281	3.000	1.126	0.178	0.107	0.000	0.000	0.000	6.191
E	0.205	0.842	0.913	0.225	0.036	0.000	0.000	0.000	0.000	2.220
ESE	0.118	0.415	0.593	0.071	0.036	0.000	0.000	0.000	0.000	1.232
SE	0.126	0.498	0.581	0.130	0.071	0.024	0.012	0.000	0.000	1.442
SSE	0.213	0.901	0.925	0.427	0.095	0.119	0.059	0.000	0.000	2.739
S	0.490	1.399	2.798	1.636	0.759	0.202	0.107	0.012	0.000	7.402
SSW	0.667	1.435	4.280	4.304	2.502	2.075	0.095	0.000	0.000	15.358
SW	0.632	2.324	3.095	1.743	0.462	0.237	0.024	0.000	0.000	8.517
WSW	0.549	2.786	1.921	0.522	0.249	0.083	0.024	0.000	0.000	6.134
W	0.458	2.419	1.506	0.545	0.368	0.403	0.012	0.000	0.000	5.711
WNW	0.396	2.063	1.328	0.771	0.664	0.877	0.095	0.000	0.000	6.194
NW	0.383	1.909	1.375	0.783	0.783	1.269	0.047	0.012	0.000	6.561
NNW	0.280	0.972	1.423	1.269	0.972	1.020	0.047	0.000	0.000	5.983
SUBTOTAL	5.964	21.567	29.535	19.623	11.880	10.730	0.676	0.024	0.000	100.000

TOTAL HOURS OF VALID WIND OBSERVATIONS	8434
TOTAL HOURS OF OBSERVATIONS	8784
RECOVERABILITY PERCENTAGE	96.0
TOTAL HOURS CALM	503

METEOROLOGICAL FACILITY: WATTS BAR NUCLEAR PLANT
WIND SPEED AND DIRECTION MEASURED AT 9.72 METER LEVEL

DATE PRINTED: 25-OCT-94

MEAN WIND SPEED = 3.63

NOTE: TOTALS AND SUBTOTALS ARE OBTAINED FROM UNROUNDED NUMBERS

JOINT PERCENTAGE FREQUENCIES OF WIND SPEED BY STABILITY CLASS

WATTS BAR NUCLEAR PLANT

JAN 1, 92 - DEC 31, 92

WIND SPEED (MPH)	STABLILITY CLASS A	B	C	D	E	F	G
CALM	0.000	0.000	0.000	0.237	1.851	2.623	1.258
0.6- 1.4	0.000	0.000	0.024	2.445	7.785	7.477	3.845
1.5- 3.4	0.309	0.688	1.080	12.390	9.862	3.810	1.400
3.5- 5.4	1.068	1.578	1.828	10.871	3.964	0.261	0.024
5.5- 7.4	0.938	0.653	1.044	7.441	1.804	0.000	0.000
7.5-12.4	0.926	0.783	1.092	7.216	0.724	0.000	0.000
12.5-18.4	0.047	0.059	0.131	0.368	0.071	0.000	0.000
18.5-24.4	0.000	0.000	0.000	0.012	0.012	0.000	0.000
>=24.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	3.287	3.762	5.198	40.980	26.074	14.170	6.527

TOTAL HOURS OF VALID STABILITY OBSERVATIONS	8688
TOTAL HOURS OF VALID WIND DIRECTION-WIND SPEED-STABILITY OBSERVATIONS	8426
TOTAL HOURS OF OBSERVATIONS	8784
JOINT RECOVERABILITY PERCENTAGE	95.9

METEOROLOGICAL FACILITY: WATTS BAR NUCLEAR PLANT
STABILITY BASED ON DELTA-T BETWEEN 9.51 AND 45.63 METERS
WIND SPEED AND DIRECTION MEASURED AT 9.72 METER LEVEL

DATE PRINTED: 25-OCT-94

ATTACHMENT

Question 21

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION

TENNESSEE DIVISION OF WATER POLLUTION CONTROL
150 NINTH AVENUE NORTH
NASHVILLE, TENNESSEE 37243-1534

92082500180

AUGUST 17, 1992

MR. W.C. MCARTHUR:
MANAGER, TECHNICAL PROGRAMS
TENNESSEE VALLEY AUTHORITY
1101 MARKET STREET
CHATTANOOGA, TENNESSEE 37402

GLF/SLH
yes discuss w/WCM on Mon. 8/31 @ 11:00 - gmb

Routing to	Note	Date
MGF		
GLFP	✓	✓
TP		
[illegible]		
FM		
NS		
RADCN		
SEC		
[illegible]		

DEAR MR. MCARTHUR:

THIS IS IN RESPONSE TO YOUR LETTER DATED JUNE 25, 1992 REGARDING THE USE OF CLAM-TROL TO INHIBIT THE INFESTATION OF ZEBRA MUSSELS AND CLAMS AT YOUR SEQUOYAH AND WATTS BAR NUCLEAR PLANTS.

WE ARE IN AGREEMENT WITH YOUR PROPOSAL TO CONDUCT TOXICITY TESTING ON THE DISCHARGES FROM THESE PLANTS WHILE THE CLAM-TROL IS IN USE. HOWEVER, SINCE NO CHEMICAL SPECIFIC PARAMETERS ARE IN PLACE FOR THIS MATERIAL WE REQUEST THAT YOU CONDUCT TOXICITY TESTING TO ESTABLISH THE LC50 AND NOEL VALUES FOR THE EFFLUENT FROM THESE FACILITIES AND REPORT THIS INFORMATION TO THE DIVISION FOR REVIEW. BASED ON THE RESULTS OF THESE TESTS WE WILL THEN DETERMINE IF FURTHER REPORTING WILL BE NECESSARY.

IF YOU HAVE ANY QUESTIONS ON THIS MATTER PLEASE CONTACT BOB O'DETTE AT 615-741-7883.

SINCERELY,

Thomas E. Roehm

THOMAS E. ROEHM
MANAGER, INDUSTRIAL FACILITIES SECTION

C.C. BOB O'DETTE