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COOLING TOWERS

A Bibliography

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COOLING TOWERS

A Bibliography

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Compiled by

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U. S. DEPARTMENT OF ENERGY
Technical Information Center

Abstract

Included are 426 citations to references on cooling towers for fossil-fuel or nuclear power plants. A few citations are included on other types of condenser cooling systems, e.g., cooling ponds and canals. The citations were taken from the DOE Energy Information Data Base (EDB) covering the period January 1979 through December 1979. Corporate, Personal Author, Subject, and Report Number Indexes are provided.

Introduction

This bibliography cites references containing information on various aspects of large cooling tower technology, including design, construction, operation, performance, economics, and environmental effects. The towers considered include natural draft and mechanical draft types employing wet, dry, or combination wet-dry cooling. A few references deal with alternative cooling methods, principally ponds or canals. The citations were compiled from the DOE Energy Information Data Base (EDB) covering the period January 1979 (EDB File No. 79R 1224) through December 1979 (EDB File No. 79J 138307). Report citations are arranged alphabetically by report number; non-report literature citations are arranged chronologically. Corporate, Personal Author, Subject, and Report Number Indexes are provided.

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ABSTRACTS

1 (AD-A--061684) ENVIRONMENTAL AND ECOLOGY BRANCH PROGRESS REPORT, 1974 THROUGH 1976. VOLUME II. FINAL REPORT, 1 JANUARY 1974-31 DECEMBER 1976. Adams, A.P.; Choules, G.L.; Crane, G.T.; Faulkner, F.; Garbett, M. (Army Test and Evaluation Command, Dugway, UT (USA)). Jun 1978. 46p. NTIS PC A03/MF A01.

In accordance with the National Environmental Policy Act (NEPA), all projects at Dugway Proving Ground (DPG) are evaluated for their potential for causing adverse environmental impact. Environmental studies for other U.S. Army installations include baseline ecological surveys, demography of jackrabbits and selected rodents. These programs have provided population and toxicological baseline data on wildlife. Investigations have been made of hazards associated with bacterial aerosols generated by cooling towers using biocontaminated wastewater. The organic nitrogen wastes generated by manufacture of Army explosives have been studied with regard to aeration rates, residence times, nutrient requirements and other physical and biological factors. A handbook for evaluating ecological effects of pollution on DARCOM installations has been prepared for the Pollution Abatement and Environmental Control Technical Lead Laboratory. Consultation services concerning environmental and epidemiological problems and mosquito control were provided to the Facilities Engineering Directorate of U.S. Army, Yuma Proving Ground, Arizona. (Author)

2 (AED-Conf--77-561-002) INVESTIGATIONS CONCERNING THE DEVELOPMENT OF DESIGN PARAMETERS FOR A LARGE-CAPACITY HYBRID COOLING TOWER BY A GROUP OF OPERATORS. Maeule, R. (Neckarwerke Elektrizitaetsversorgungs-A.G., Esslingen (Germany, F.R.)). (Zentralstelle fuer Atomkernenergie-Dokumentation (ZAED), Eggenstein-Leopoldshafen (Germany, F.R.)). 1977. 10p. (In German). (CONF-771262--2). Dep. NTIS (US Sales Only), PC A02/MF A01.

From Technical meeting on cooling tower operation; Duesseldorf, F.R. Germany (2 Dec 1977).

A group of operators will investigate the efficiency of hybrid cooling towers on a collaborative basis. In a first phase, in cooperation with staff members from university institutes, calculation models for plume diffusion are examined with a view to their sensitivity in the variational region of the tower exhaust air conditions, and they are adapted appropriately. The function of the design parameters is developed and evaluated.

3 (AED-Conf--77-561-003) CONSTRUCTIONAL TYPES OF HYBRID TOWER CELLS. FIRST PLUME OBSERVATIONS ON EXPERIMENTAL CELLS IN THE GEMEINSCHAFTSKERNKRAFTWERK NECKAR (GKN). Maeule, R. (Neckarwerke Elektrizitaetsversorgungs-A.G., Esslingen (Germany, F.R.)). (Zentralstelle fuer Atomkernenergie-Dokumentation (ZAED), Eggenstein-Leopoldshafen (Germany, F.R.)). 1977. 8p. (In German). (CONF-771262--1). Dep. NTIS (US Sales Only), PC A02/MF A01.

From Technical meeting on cooling tower operation; Duesseldorf, F.R. Germany (2 Dec 1977).

First experience with two experimental hybrid-cell cooling towers at the Gemeinschaftkernkraftwerk Neckar (GKN) concerning techniques and plume influence. In dependence of plume-determining parameters coinciding, noticeable plume reductions as well as situations without visible improvements are observed. These results, which are not quite clear, demonstrate that systematical analytical investigations are needed.

4 (AED-Conf--77-561-004) CONSTRUCTION AND PLUME OBSERVATION ON A DRY/WET TEST CELL IN THE MARBACH III POWER PLANT. Beising, R. (Energie-Versorgung Schwaben A.G., Stuttgart (Germany, F.R.)). (Zentralstelle fuer Atomkernenergie-Dokumentation (ZAED), Eggenstein-Leopoldshafen (Germany, F.R.)). 1977. 9p. (In German). (CONF-771262--3). Dep. NTIS (US Sales Only), PC A02/MF A01.

From Technical meeting on cooling tower operation; Duesseldorf, F.R. Germany (2 Dec 1977).

Using a wet/dry prototype cooling tower in addition to the existing wet cooling tower cells, the possibility was given in Marbach to study this new cooling technique which had not been tested before in the Federal Republic. It was found that combined cooling with plastic heat exchangers is a promising way to shorten the plumes, although in varying degrees, and to save water due to lower evaporation losses. It should be noted, however, that the plume behaviour observed cannot be used to draw conclusions on high-power dry/wet cooling towers, e.g. for a 1300 MW power plant unit.

5 (AED-Conf--77-561-005) PRESENT KNOWLEDGE ON PHYSICAL RELATIONS IN DRIFT EJECTION FROM WET COOLING TOWERS AND HITHERTO APPLIED MEASURING METHODS TO DETERMINE THE DROPLET SIZE. Vodicka, V. (Balcke-Duerr A.G., Bochum (Germany, F.R.)). (Zentralstelle fuer Atomkernenergie-Dokumentation (ZAED), Eggenstein-Leopoldshafen (Germany, F.R.)). 1977. 12p. (In German). (CONF-771262--4). Dep. NTIS (US Sales Only), PC A03/MF A01.

From Technical meeting on cooling tower operation; Duesseldorf, F.R. Germany (2 Dec 1977).

Modern cooling towers are equipped with

drift eliminators. Besides the knowledge of the spray loss ejection rate, the drift spectrum of the spray loss is also of interest. Possibilities of improving the degree of separation of the drift eliminators are shown by means of theories. These considerations are confirmed by measurements. Furthermore, measuring methods of the drift ejection rate and the droplet size determination are given. Finally, drift spectra of various drift eliminator and cooling tower constructions are given.

6 (ASHRAE/GRP--170, pp XIII.1-XIII.7) APPLICATIONS OF SOLAR ENERGY FOR HEATING AND COOLING OF BUILDINGS: SOLAR COOLING. Newton, A.E. 1977.

Applications of solar energy for heating and cooling of buildings.

The performance of solar-energized cooling equipment is related to load patterns, to the duration and frequency of ambient temperature levels, to available insolation and collection capability, and to storages. Several types of cooling equipment which operate from heat obtained from solar collector systems are described. The heat-activated cycles discussed are the lithium-bromide-water absorption cycle, the adsorption cycle, and the Rankine system. Heat pumps as auxilliaries to solar systems are briefly considered.

7 (ATDL--77/23) ENVIRONMENTAL RESEARCH LABORATORIES 1976 ANNUAL REPORT. (National Oceanic and Atmospheric Administration, Oak Ridge, TN (USA). Atmospheric Turbulence and Diffusion Lab.). Sep 1977. 630p. Dep. NTIS, PC A99/MF A01.

Separate abstracts were prepared for 17 sections of this report. A list is included of 28 publications during the time period covered.

8 (ATDL--77/23, pp 511-522) DAILY OBSERVATIONS OF VISIBLE PLUME LENGTH AT TVA'S PARADISE COOLING TOWERS. Hanna, S.R.; Pike, M. (Air Resources Atmospheric Turbulence and Diffusion Lab., Oak Ridge, TN). Sep 1977.

Environmental Research Laboratories 1976 annual report.

Observations of visible plume length taken each morning at TVA's Paradise Steam Plant cooling towers show only a slight correlation with ambient saturation deficit and wind speed, and very little dependence on season or weather type. Average visible plume height and length are 270 m and 360 m, respectively, with standard deviations of 120 m and 380 m.

9 (ATDL--77/23, pp 531-555) PREDICTED CLIMATOLOGY OF COOLING TOWER PLUMES FROM ENERGY CENTERS. Hanna, S.R. (Air Resources Atmospheric Turbulence and Diffusion Lab., Oak Ridge, TN). Sep 1977.

Environmental Research Laboratories 1976 annual report.

A one dimensional plume and cloud growth model is applied to four months of radiosonde observations from Nashville, using as initial conditions the plume from single large cooling towers with waste heat outputs of 10^3, 10^4, 10^5 MW, and a complex of cooling towers with a total waste heat output of 10^5 MW. Estimates of average annual plume rise from the four energy sources are 580, 1180, 2460, and 780 m, respectively. The predicted plume rise, visible plume length, and cloud formation are given as functions of time of day, year, and weather type. For example, a cloud forms at the top of the plume from the 10^3 MW tower in 65% of the morning soundings during which ground level fog was observed. A cloud is predicted to occur 95% of the time at the top of the plume from the single 10^5 MW tower. It is found that if the towers in an energy center are separated by a distance greater than the average plume rise from one tower, then plume merging is minimized. Observations from TVA's Paradise Steam Plant are used to test the predictions of visible plume length from a single 10^3 MW tower.

10 (ATDL--77/23, pp 239-244) OBSERVED AND PREDICTED COOLING TOWER PLUME RISE AT THE JOHN E. AMOS POWER PLANT, WEST VIRGINIA. Hanna, S.R. Sep 1977.

Environmental Research Laboratories 1976 annual report.

There is much current interest in cooling tower plume rise because of its importance in determining the environmental impact of cooling towers at planned power plants and industrial facilities. Some of the possible environmental problems related to heat and water emissions from cooling towers are drift deposition, ground level fog, cloud formation, and precipitation enhancement. An important factor in all of these problems is the calculation of the plume trajectory, which is often complicated by the presence of multiple sources and water phase changes in the plume. The latent heat does not strongly influence plume rise if there is no cloud present at the top of the plume. A one dimensional plume and cloud growth model was developed to study these effects. In this paper, the predictions of the model are compared with observations of cooling tower plume rise at the John E. Amos, W. Va. fossil-fuel power plant.

11 (ATDL--77/23, pp 351-457) FIRST ANNUAL REPORT ON WEATHER MODIFICATION EFFECTS OF COOLING TOWERS. Hanna, S.R.; Hosker, R.P. Jr. (Air Resources Atmospheric Turbulence and Diffusion Lab., Oak Ridge, TN). Sep 1977.

Environmental Research Laboratories 1976 annual report.

Single cooling towers emit as much as 1000 MW of sensible and latent heat to the atmosphere. Planned energy centers or power parks may contain clusters of cooling towers which emit a total of 100,000 MW. Heat releases of this magnitude have the potential to significantly alter local weather. Cooling towers can also alter the local environment by the production of fog and clouds, and the deposition of drift salts. A basic one-dimensional mathematical model is presented for plume and cloud growth in the vicinity of cooling towers. Since the cooling tower emissions are usually constant with time, at least over time periods less than four or five hours, the steady-state assumption is good. Phenomena such as multiple plume merging and changes in the environmental air surrounding the plume are accounted for only by crude parameterization. Applications in analysis of the environmental effects of cooling towers at fossil-fuel and nuclear power plants are reported.

12 (ATDL--77/23, pp 523-530) SECONDARY MOTIONS IN A COOLING TOWER PLUME. Hanna, S.R.; Pike, M. (Air Resources Atmospheric Turbulence and Diffusion Lab., Oak Ridge, TN). Sep 1977.

Environmental Research Laboratories 1976 annual report.

Time-lapse photography was used to estimate the speed of the vortex in the condensed plume at the edge of a bank of mechanical draft cooling towers at the Oak Ridge Gaseous

Diffusion Plant. At a distance of about 30 m from the towers, the median tangential speed is about 2 m/s in the downward direction.

13 (ATDL--77/23, pp 563-595) HYDROMETEOROLOGICAL ASPECTS OF ELECTRIC POWER PRODUCTION. Hanna, S.R. (Air Resources Atmospheric Turbulence and Diffusion Lab., Oak Ridge, TN). Sep 1977.
Environmental Research Laboratories 1976 annual report.
Observed atmospheric effects due to waste heat release from cooling towers and ponds are reviewed, including sun shading, ground fog, drift deposition, interference with aircraft, interactions with chemical plumes, high winds, and changes in cloudiness, temperature, and precipitation. It is seen that effects are generally minor from current power production facilities, but that more serious effects can be expected if large energy centers (10,000 MW and up) are built. The status of physical and mathematical modeling is summarized, and it is concluded that two or three dimensional second or third order closure models must be developed in order to assess the probability of vorticity concentration at large energy centers and adequately explain plume merging.

14 (ATDL--77/23, pp 597-627) DRIFT-MODELING AND MONITORING COMPARISONS. Chen, N.C.J. (Oak Ridge National Lab., TN); Hanna, S.R. Sep 1977.
Environmental Research Laboratories 1976 annual report.
Several drift deposition models for cooling towers are compared using a set of standard input conditions. The predicted maximum drift deposition differs by two orders of magnitude, and the downwind locations of the maximum differ by one order of magnitude. The discrepancies are attributed mainly to different assumptions in the models regarding the initial effective height of the droplets. Current programs in which drift characteristics at the tower mouth and drift deposition downwind of the tower are being measured are summarized. At the present time, drift deposition measurements, sufficiently comprehensive for model verifications, are unavailable. Hopefully, the Chalk Point Program will satisfy this need.

15 (ATDL--78/19, pp 329-332) OBSERVATIONS OF VORTICES IN COOLING TOWER PLUMES. Hanna, S.R.; Pike, M.; Seitter, K. Dec 1978.
Environmental Research Laboratories 1977 annual report.
Time-lapse photography was used to estimate the speed of vortices in condensed plumes from a bank of mechanical draft cooling towers and a hyperbolic natural draft cooling tower. At a distance of about 30 m downwind from the towers, the median tangential velocity of the vortices at the edge of the plume is about 2 m s^{-1} in the downward direction, for ambient wind speeds of 7 to 13 m s^{-1}. The standard deviation of turbulent fluctuations of tangential speeds of the vortices is about 1.8 m s^{-1} for both types of towers.

16 (ATDL--78/19) ENVIRONMENTAL RESEARCH LABORATORIES 1977 ANNUAL REPORT. (National Oceanic and Atmospheric Administration, Oak Ridge, TN (USA). Atmospheric Turbulence and Diffusion Lab.). Dec 1978. 525p. Dep. NTIS, PC A23/MF A01.
Research is reported in the following subject areas: regional-scale effects of energy generation; mesoscale transport and diffusion modeling; effluent plume behavior; forest meteorology; climatological studies. Current research programs include air transport studies, especially in rough terrain; air pollution studies; the meteorological effects of cooling towers and energy production; research on plume and wake behavior (including effects of buoyancy, active thermal convection, building wake interaction, and removal processes); extension of atmospheric transport, diffusion, and effluent removal models to special situations such as over-water and over-forest flows; and study of the role of forest structure on the atmospheric energy balance and on diffusion. Separate abstracts were prepared for those studies on scope for ERA/EDB. (JGB)

17 (ATDL--78/19, pp 133-233) ATMOSPHERIC EFFECTS OF ENERGY GENERATION. Hanna, S.R. Dec 1978.
Environmental Research Laboratories 1977 annual report.
The effects of excess heat and moisture released to the atmosphere as the result of energy generation is discussed. Specific methods for estimating effects such as cloud formation or drift deposition are outlined. The cooling tower is the source that is most thoroughly treated.

18 (ATDL--78/19, pp 430-469) REPORT ON ATDL RESEARCH ON METEOROLOGICAL EFFECTS OF THERMAL ENERGY RELEASES. Hanna, S.R.; Rao, K.S.; Hosker, R.P. Dec 1978.
Environmental Research Laboratories 1977 annual report.
Illustrations are given of applications of the ATDL Plume and Cloud Growth Model to the following facilities: John E. Amos Plant, Los Angeles oil refineries, Chalk Point Plant, and Paradise Plant. Research in the following areas is also reported: secondary motions in cooling tower plumes, analysis of observed plume cross sections at Chalk Point, analysis of satellite photographs of moisture and smoke plumes, and a numerical model of meteorological effects of waste heat and moisture releases from hypothetical power parks.

19 (BNL--50564) NOISE RADIATION FROM ENERGY CENTER COOLING TOWERS. Zakaria, J.; Moore, F. (Brookhaven National Lab., Upton, NY (USA). National Center for Analysis of Energy Systems). Dec 1976. Contract EY-76-C-02-0016. 64p. Dep. NTIS, PC A04/MF A01.
Noise levels from the cooling towers of clustered and dispersed arrays of cooling towers for large power plants are presented, and a procedure is presented for the prediction of noise levels at some distance from the rim of a single isolated tower. Two types of cooling systems, namely mechanical-draft wet and natural-draft wet cooling towers, are considered, which are assumed to act as the sole source of noise generation in power plants. The procedure for the prediction of noise levels from single isolated towers is then extended to determine noise levels at some point on the site boundary of energy centers being proposed for the future. It is concluded that if one wishes to minimize the area impacted by objectionable noise levels, then for concentrated power centers either mechanical-draft or natural-draft towers may be chosen, while for more widely dispersed centers natural-draft systems must be recommended. Special emphasis has been placed upon the A-weighted sound levels, which correlate well with human sound perception. One dimensional free wave spreading and atmospheric absorption are the attenuation factors taken into account.

20 (BNWL--2268(Rev.)) OVERVIEW OF ISSUES AFFECTING THE DEMAND FOR DRY AND WET/DRY COOLING FOR THERMAL POWER PLANTS. Hendrickson, P.L. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Sep 1978. Contract EY-76-C-06-1830. 70p. Dep. NTIS, PC A04/MF A01.

The Dry Cooling Enhancement Program was initiated to: develop economic and performance models for cost optimization of total heat rejection systems using dry and dry/wet cooling; analyze and disseminate operating experience on existing dry-cooled plant performance; and demonstrate certain features of existing technology equipment to provide confidence for specification by utilities. The ultimate objective was to promote water conservation through industry use of dry cooling by developing and demonstrating the reliability of lower-cost systems. The economic, legal, and water availability factors that will contribute to future selection of dry and wet/dry cooling and thus influence the projected market for these types of cooling systems in the next 20 years are considered.

21 (BNWL-SA--6165) STUDY OF THE COMPARATIVE COSTS OF FIVE WET/DRY COOLING TOWER CONCEPTS. Allemann, R.T.; Feletti, D.W.; Johnson, B.M.; Parry, H.L.; Smith, G.C.; Tokarz, R.D.; Walter, R.A.; Zaloudek, F.R. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Jun 1977. Contract EY-76-C-06-1830. 24p. (CONF-770611--42). Dep. NTIS, PC A02/MF A01.

From American Nuclear Society annual meeting; New York, NY, USA (12 Jun 1977).

A previous study undertaken to ascertain the economic incentives for further development of advanced dry/wet cooling towers showed that an advanced dry cooling concept using ammonia as an intermediate cooling fluid reduced the incremental cost of dry cooling by approximately 25 to 30%. This paper presents the projected costs of five alternative dry/wet concepts, one of which involves a similar use of ammonia. This study concludes that although absolute quantitative cost estimates for these cooling systems are uncertain, the relative cost studies indicate that wet/dry cooling systems using ammonia may be competitive with commercially available systems and that the deluge system which links dry and evaporative cooling in an ammonia system should be developed in order to provide a more accurate assessment of the system cost and reliability. (LCL)

22 (BNWL-SA--6290) DRY COOLING FOR POWER PLANTS: INCENTIVES, PROBLEMS, AND R AND D ACTIVITIES. Johnson, B.M.; Maulbetsch, J.S. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Apr 1977. Contract EY-76-C-06-1830. 24p. (CONF-770516--13). Dep. NTIS, PC A02/MF A01.

From Conference on waste heat management and utilization; Miami Beach, FL, USA (9 May 1977).

Portions of document are illegible.

Projecting the use of dry cooling at steam-electric plants within the next twenty years is fraught with more than the usual amount of uncertainty associated with long-range predictions. Eventually the industry's cooling requirements may exceed the availability of cooling water and require the direct rejection of heat to the atmosphere. However, projecting the physical availability of water and the growth of power generating capacity in various regions is not sufficient to determine the use of dry cooling within a twenty-year time frame. The use will be largely determined by legislative decisions on the use of limited inland water resources and the accessibility of seawater for cooling in coastal areas. These legislative decisions, in turn, will be influenced by the perceived impact of dry cooling upon the cost and conservation of energy. Research and development in progress is focused on reducing the total evaluated cost of dry cooling through reducing the capital cost and/or reducing the cost of providing replacement energy and generating capability. The incentives, problems and research/development activities are reviewed to provide an overview of potential improvements in dry cooling and the impact they may have on future power plant construction.

23 (CONF-740107--2) AIRBORNE TRANSMISSION OF PATHOGENIC ORGANISMS IN COOLING TOWER DRIFT. Lewis, B.G. (Argonne National Lab., IL (USA)). 1974. Contract W-31-109-ENG-38. 42p. Dep. NTIS, PC A03/MF A01.

From Cooling Tower Institute annual meeting; New Orleans, LA, USA (28 Jan 1974).

The siting of cooling towers on sewage-polluted waters, and the probable widespread use in the future of treated sewage effluent as makeup, has raised the question of dispersal of pathogenic organisms in cooling tower drift. This question has public health implications and needs an answer before the environmental effects of cooling towers can be fully evaluated. Some information pertinent to this question, e.g., the occurrence of pathogenic organisms, the factors that affect their survival in water and air, and the relation to public health, is discussed. Some approaches to the problem are also presented.

24 (CONF-741270--P2, pp 406-412) SALT WATER COOLING PONDS WITH PARTIAL TIDAL INTERCHANGE. Baure, H.E. (New Zealand Electricity Dept., Wellington). 1974.

From 5. Australasian conference on hydraulics and fluid mechanics; Christchurch, New Zealand (9 Dec 1974).

The results of a preliminary investigation of the feasibility of using a salt water cooling pond with partial tidal interchange for the rejection of heat from the circulating water system of a thermal power station are presented. A computer simulation of the cooling pond system is described and the operating conditions of a cooling pond of sufficient size for a 1000 MW power station are discussed. The results for a completely closed pond and a partially open pond are compared.

25 (CONF-760429--, pp 329-346) POTENTIAL ENVIRONMENTAL EFFECTS ASSOCIATED WITH BRACKISH WATER COOLING TOWERS AT CHALK POINT, MARYLAND. Mulchi, C.L.; Wolf, D.C.; Foss, J.E.; Armbruster, J.A.; Curtis, C.R.; Israel, G. (Univ. of Maryland, College Park). 1978.

From 2. mineral cycling symposia on environmental chemistry and cycling processes; Augusta, GA, USA (28 Apr 1976).

The departments of agronomy, botany, and meteorology at the University of Maryland initiated a 10-year research and monitoring program to assess the effects of saline aerosol drift from natural-draft cooling towers at Chalk Point, Md., on the crops, soils, and native plant species in the area. Twelve research sites approx. 0.16 ha in area were established in 1973 at distances 1.6, 4.8, and 9.6 km in four directions (north, east, south, and west) from the towers. Base-line information on dust-fall particulates (Na^+ and Cl^- deposition), precipitation (Na^+, Cl^-, and

pH values), and ambient SO_2 levels was collected on a monthly basis for 24 months before tower operations were initiated in 1975. Also, chemical and physical properties of soils at the sites were examined, and the growth and chemical content of six agricultural crop species were determined during the preoperational period. One year of postoperational data on these parameters have been collected and analyzed. In general, no substantial changes in any of the parameters being monitored were observed during the first year of tower operation at Chalk Point.

26 (CONF-760588--P3, pp 303-311) NON-IDEAL FLOW MODEL FOR THE DESIGN OF SPRAY TOWERS FOR THE RECOVERY OF LOW GRADE HEAT. Liddle, C.J. (Lenkro Chemicals Ltd., Manchester, Eng.). 1976.

From 5. international symposium on fresh water from the sea; Alghero, Italy (16 May 1976).

Based on extensive laboratory tests, a correlation for the holdup characteristics and a new model of non-ideal flow in direct contact, liquid-liquid spray towers have been developed. Using the correlation as a scale-up device, it is shown how such data may be used to establish the diameter of a full-scale column. Likewise, the mathematical model, based on a tanks-in-series with bypass and time delay representation, should provide a sound basis for establishing the height of the equipment. Thus the geometry and thermal performance of this type of unit can be readily scaled-up from laboratory results using the techniques presented here.

27 (CONF-770509--, pp 1-12) CRITICAL PATHS TO COAL UTILIZATION. Hill, G.R. (Electric Power Research Inst., Palo Alto, CA). 1978.

From Scientific problems relevant to coal utilization; Morgantown, WV, USA (23 May 1977).

The present dilemma of energy producers, converters, and policy decision makers is presented. The consequences of environmental control regulations, coupled with the need for conservation of energy and of energy resources on the increased utilization of coal, are discussed. Several recent technical accomplishments that make possible increased utilization of coal for power generation are described. Groundwork is laid for discussion of the technical development which must occur if the United States is to retain its energy viability.

28 (CONF-771042--, pp 69-75) HEAT SHOCK THRESHOLD ESTIMATION FOR FISH EGGS AND LARVAE IN POWER PLANT COOLING SYSTEMS. Marcus, A.H. (Washington State Univ., Pullman). Mar 1978.

From 3. ERDA statistical symposium; Richland, WA, USA (26 Oct 1977).

Although mortality and hatching success data are often analyzed by bicassay methods (e.g., probits or logits), it is suspected that actual thresholds exist for the adaptive response of a biological system to multiple environmental stresses. These thresholds can be estimated using a general linear model. The optimal estimation of the response thresholds is a nonlinear least-squares problem, however, and the derivatives of the residual sum of squares surface will have cusps. Approximate confidence regions for thresholds are readily calculated. The separate effects of temperature shock and cumulative temperature dose in electric power plant cooling systems are shown for hatching success of striped bass eggs and for mortality of the larvae of the American shad.

29 (CONF-771153--P2, pp E.83-E.107) ENVIRONMENTAL ASSESSMENT OF THE PROJECTED USES FOR GEOPRESSURED WATERS. Wilson, J.S.; Manning, J.A. (Dow Chemical, Freeport, TX). 1977.

From 3. geopressured geothermal energy conference; Lafayette, LA, USA (16 Nov 1977).

An assessment of possible environmental effects of the use of geopressured water of the Texas and Louisiana Gulf Coast has been made. The uses considered include generation of electric power, production of low pressure steam for process heat and the direct use of the hot water for space heating. Based upon the projected uses, the direct and indirect emissions are estimated and the impact of these emissions upon the environment are discussed. The possible impacts of the production of large volumes of geopressured fluids are also considered in terms of possibility of subsidence and earthquakes. A summary of available analyses of Gulf Coast deep waters is listed as a guide for estimating expected emissions. Primary environmental problems are identified as waste brine disposal, accidental releases of brines, and subsidence. Minor problems such as cooling tower blowdown streams, noncondensable gas emissions, wind drift from exhaust plumes, noise levels, and construction activities are considered.

30 (CONF-771203--, pp 577-579) CLEAN ENERGY FROM HUMID AIR. Oliver, T.K.; Groves, W.N.; Gruber, C.L.; Cheung, A. (South Dakota School of Mines and Technology, Rapid City). 1977.

From Alternative energy sources symposium; Miami Beach, FL, USA (5 Dec 1977).

WIND POWER;NATURAL DRAFT COOLING TOWERS;AIR; HUMIDITY;VAPORIZATION HEAT;ECONOMICS; FEASIBILITY STUDIES

31 (CONF-780520--7) ENVIRONMENTAL EFFECTS OF HEAT AND MOISTURE RELEASE FROM ATMOSPHERIC SPRAY COOLING SYSTEMS. Chaturvedi, S.; Porter, R.W. (Illinois Inst. of Tech., Chicago (USA)). 1978. Contract EC-77-S-02-4531. 11p. Dep. NTIS, PC A02/MF A01.

From 2. thermophysics and heat transfer conference; Palo Alto, CA, USA (24 May 1978).

The present work deals with a source of finite width and height with a distributed internal heat and moisture release consistent with a thermal model for atmospheric sprays including heating and humidification of downwind elements. The self-consistent fully-developed ambient wind and turbulent diffusivity profiles depending on aerodynamic surface roughness and atmospheric stability are presumed to prevail throughout the domain of interest. The convective diffusion equation governing the enthalpy of the air-moisture mixture is integrated numerically continuing through and beyond the source, and the local temperature and vapor concentration are computed. Fogging is described by an equilibrium model which requires condensation of vapor in excess of saturation. Ground-level dispersent concentration and height are compared with those of ground-level line sources and of field and wind-tunnel experiments with a finite source.

32 (CONF-780701--(Rev.), pp 137-146) SOLAR ASSISTED HEAT PUMPS FOR MOTEL APPLICATIONS IN LA QUINTA MOTOR INN, SALT LAKE CITY, UTAH. Rubin, M. (La Quinta Motor Inns, Inc., San Antonio, TX); Orlowski, H. Nov 1978.

From Conference on the energy solar updates; Atlanta, GA, USA (12 Jul 1978).

Solar energy systems designed for the La

Quinta Motor Inns interface between two newly developing mechanical technologies, solar energy, and the water source heat pump. The low temperature thermal requirement of the water source heat pump makes it an excellent match for the use of low temperature solar energy, and as such adds the benefit of a smaller solar energy system, with its lower associated cost. The Salt Lake City project will consist of 122 rooms utilizing a net collector array of 3000 square feet, which is anticipated will provide 25% of the heating requirement and 61% of the domestic hot water. Total installation cost is anticipated to be $250,000.

33 (CONF-781106--1) METEOROLOGICAL EFFECTS OF HEAT AND MOISTURE RELEASES FROM LARGE POWER STATIONS (PRECIPITATION MODIFICATION). Patrinos, A.A.N.; Eissenberg, D.M. (Oak Ridge National Lab., TN (USA)). 1978. Contract W-740-ENG-26. 2Sp. (CONF-780520--6). Dep. NTIS, PC A03/MF A01.

From Meeting on thermal power plant heat rejection systems; Yerovan, USSR (10 Nov 1978).

The Bowen Electric Generating Plant (Plant Bowen) in Northwest Georgia has been chosen as a test site to investigate the atmospheric effects of cooling towers. This 3,200-MWe coal-fired power plant uses four natural-draft cooling towers and is the largest of U.S. power plants having cooling towers as the sole cooling method. Results are reported from both climatological and field studies. Extensive use has been made of the U.S. National Weather Service (NWS) data accumulated over several decades in Northwest Georgia. Apart from providing preliminary indications of precipitation modification effects, these data have aided in the general understanding of the climatology in the vicinity of Plant Bowen and have paved the way for the field studies currently underway. These field studies, employing a dense network of rain gauges and windsets, are expected to provide the statistical data base necessary to estimate the plant's effect (if any) on precipitation.

34 (CONF-781109--14) ASSESSMENT OF ONCE THROUGH COOLING WATER CONTROL TECHNOLOGY. Paddock, R.A.; Ditmars, J.D. (Argonne National Lab., IL (USA)). 1978. Contract W-31-109-ENG-38. 26p. Dep. NTIS, PC A03/MF A01.

From Environmental control symposium; Washington, DC, USA (26 Nov 1978).

The efficacy of the disposal of waste heat from electric power generation by means of once through cooling systems was examined in the context of the physical aspects of water quality standards and guidelines for thermal discharges. The ranges of water temperature standards and mixing zone requirements were determined for rivers, lakes, estuaries, and coastal waters. Various modes of once through cooling water disposal from each of four generic plants were examined in terms of general characteristics of each of the receiving water types. The focus of the examination of the disposal modes, surface and submerged discharges, was the likelihood that a given disposal could be effected within the restrictions of the thermal standards for the given receiving water type. The results of prototype measurements and of model studies of thermal plume behavior were employed to determine generalized and schematic behavior of surface and submerged discharges into the various types of receiving waters. General guidelines were produced that indicated, for a given type of plant, for a given discharge mode, and for a given type of receiving water body, the opportunity for once through cooling water discharge within the given temperature and mixing zone requirements. Similar assessments have been made for all other combinations of plant, discharge, and receiving water types. While specific guidelines are provided for each receiving water type, the general conclusion reached is that submerged multiport diffusers provide the greatest opportunity to meet thermal standards in all environments.

35 (CONF-781213--3) BEHAVIOR OF THE THERMAL SKIN OF COOLING POND WATERS SUBJECTED TO MODERATE WIND SPEEDS. Wesely, M.L. (Argonne National Lab., IL (USA)). 1978. Contract W-31-109-ENG-38. 12p. Dep. NTIS, PC A02/MF A01.

From Winter simulation conference; Miami Beach, FL, USA (4 Dec 1978).

The temperature difference $\Delta T/sub\ delta/$ across the partially laminar skin of water on the surface of a water body is determined by the total heat transfer Q through the skin, the wind speed u, and the mean temperature $T/sub\ delta/$ of the skin. Systematic measurements of these variables were made over a wide range of conditions at a cooling pond in northeastern Illinois. Waves were present in all cases; the wind speeds were $u = 2.5$ to $7.0\ m\ s^{-1}$ at a height of 1 m and water temperatures were $T/sub\ delta/ = 18$ to $37.5^{o}C$. The main result is the equation $\Delta T/sub\ delta/ = 11.5\ \gamma/sup\ 2/3/kappa/sup\ 1/3/Qk^{-1}(tau/rho/sub\ w/)/sup\ -1/3/$, where γ is the water viscosity, kappa is the thermal diffusivity of water, k is the water thermal conductivity, tau is the wind shearing stress, and $rho/sub\ w/$ is the water density.

36 (CONF-781213--5) PREDICTION OF LOCAL EFFECTS OF PROPOSED COOLING PONDS. Hicks, B.B. (Argonne National Lab., IL (USA)). 1978. Contract W-31-109-ENG-38. 9p. Dep. NTIS, PC A02/MF A01.

From Winter simulation conference; Miami Beach, FL, USA (4 Dec 1978).

A Fog Excess Water (FEW) Index has been shown to provide a good measure of the likelihood for steam fog to occur at specific cooling pond installations. The FEW Index is derived from the assumption that the surface boundary layer over a cooling pond will be strongly convective, and that highly efficient vertical transport mechanisms will result in a thorough mixing of air saturated at surface temperature with ambient air aloft. Available data support this assumption. An extension of this approach can be used to derive a simple indicator for use in predicting the formation of rime ice in the immediate downwind environs of a cooling pond. In this case, it is supposed that rime ice will be deposited whenever steam fog and sub-freezing surface temperatures are predicted. This provides a convenient method for interpreting pre-existing meteorological information in order to assess possible icing effects while in the early design stages of the planning process. However, it remains necessary to derive accurate predictions of the cooling pond water surface temperature. Once a suitable and proven procedure for this purpose has been demonstrated, it is then a simple matter to employ the FEW Index in evaluations of the relative merits of alternative cooling pond designs, with the purpose of minimizing overall environmental impact.

37 (CONF-790109--1) COOLING TOWER DRIFT STUDIES AT THE PADUCAH, KENTUCKY GASEOUS DIFFUSION PLANT. Taylor, F.G.; Hanna, S.R.; Parr, P.D. (Oak Ridge National Lab., TN

(USA)). 1979. Contract W-7405-ENG-26. 31p. Dep. NTIS, PC A03/MF A01.
From Cooling tower institute annual meeting; Houston, TX, USA (22 Jan 1979).
The transfer and fate of chromium from cooling tower drift to terrestrial ecosystems were quantified at the Department of Energy's uranium enrichment facility at Paducah, Kentucky. Chromium concentrations in plant materials (fescue grass) decreased with increasing distance from the cooing tower, ranging from 251 +- 19 ppM at 15 meters to 0.52 +- 0.07 ppM at 1500 meters. The site of drift contamination, size characteristics, and elemental content of drift particles were determined using a scanning electron microscope with energy dispersive x-ray analysis capabilities. Results indicate that elemental content in drift water (mineral residue) may not be equivalent to the content in the recirculating cooling water of the tower. This hypothesis is contrary to basic assumptions in calculating drift emissions. A laboratory study simulating throughfall from 1 to 6 inches of rain suggested that there are more exchange sites associated with litter than live foliage. Leachate from each one inch throughfall simulant removed 3% of the drift mass from litter compared to 7 to 9% from live foliage. Results suggest that differences in retention are related to chemical properties of the drift rather than physical lodging of the particle residue. To determine the potential for movement of drift-derived chromium to surface streams, soil--water samplers (wells) were placed along a distance gradient to Little Bayou Creek. Samples from two depths following rainstorms revealed the absence of vertical or horizontal movement with maximum concentrations of 0.13 ppb at 50 meters from the tower. Preliminary model estimates of drift deposition are compared to depositionmeasurements. Isopleths of the predicted deposition are useful to identify areas of maximum drift transport in the environs of the gaseous diffusion plant.

38 (CONF-790737--1) CREATION OF AN INDUSTRY INFORMATION RESOURCE TO CATALOGUE POWER PLANT COOLING SYSTEM IMPACTS AND MITIGATION MEASURES AFFECTING AQUATIC AND TERRESTRIAL ECOSYSTEMS. Hannon, E.H.; D'Angelo, L.J.; Talmage, S. (Atomic Industrial Forum, Inc., Washington, DC (USA); Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 5p. Dep. NTIS, PC A02/MF A01.
From Mitigation symposium; Ft Collins, CO, USA (17 Jul 1979).
The data base design and scope, as well as the products and services offered, for the Cooling Systems Effects Data Base are summarized.

39 (CONF-790808--16) WASTE HEAT REJECTION FROM GEOTHERMAL POWER STATIONS. Robertson, R.C. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 70p. Dep. NTIS, PC A04/MF A01.
From 18. ASME national heat transfer conference; San Diego, CA, USA (Aug 1979).
Waste heat rejection systems for geothermal power stations have a significantly greater influence on plant operating performances and costs than do corresponding systems in fossil- and nuclear-fueled stations. With thermal efficiencies of only about 10%, geothermal power cycles can reject four times as much heat per kilowatt of output. Geothermal sites in the United States tend to be in water-short areas that could require use of more expensive wet/dry or dry-type cooling towers. With relatively low-temperature heat sources, the cycle economics are more sensitive to diurnal and seasonal variations in sink temperatures. Factors such as the necessity for hydrogen sulfide scrubbers in off-gas systems or the need to treat cooling tower blowdown before reinjection can add to the cost and complexity of goethermal waste heat rejection systems. Working fluids most commonly considered for geothermal cycles are water, ammonia, Freon-22, isobutane, and isopentane. Both low-level and barometric-leg direct-contact condensers are used, and reinforced concrete has been proposed for condenser vessels. Multipass surface condensers also have wide application. Corrosion problems at some locations have led to increased interest in titanium tubing. Studies at ORNL indicate that fluted vertical tubes can enhance condensing film coefficients by factors of 4 to 7.

40 (CONF-7608122--, pp 51-56) NOISE CONTROL ENGINEERING AT THE MOBIL LUBRICATING OIL REFINERY, PORT STANVAC, SOUTH AUSTRALIA. Beadle, K.J. (Foster Wheeler Australia Pty. Ltd., Melbourne); Underwood, P.C.W. 1976.
From 4. conference on chemical engineering; Adelaide, Australia (25 Aug 1976).
Project noise control specifications are derived after consideration of world wide practice and anticipate the requirements of future state legislation. Community noise levels govern permissible noise emission from most equipment items. Purchase specifications include noise level requirements. Vendor guarantees are obtained. Noise attenuation features of installed equipment are optimized to meet noise specifications at minimum cost. Noise control engineering on a large process plant requires experienced engineers backed by a data bank of operational noise levels for standard and silenced equipment. Noise control engineering must be integrated with the plant layout and equipment specification phases of the project.

41 (CONF-7611116--P2, pp 15p, Book 2, Paper 23) CORROSION PROBLEMS IN COOLING TOWERS: THEIR PREVENTION IN PRACTICE. Oetiker, N.K.; Reid, M.B. 1976.
From 16. conference of Australasian Corrosion Association; Auckland, New Zealand (22 Nov 1976).
Electric power generating plants are finding an increasing need for cooling towers. Corrosion is the main problem in cooling towers. Mild steel, steel, and brass have been used in a study of corrosion. A formulation of HEDP and zinc in a molar ratio of 1:1 is satisfactory for preventing scale and corrosion. (FS)

42 (CONF-7809109--1) BIOLOGICAL EVALUATION OF DEVICES USED FOR REDUCING ENTRAINMENT AND IMPINGEMENT LOSSES AT THERMAL POWER PLANTS. Cada, G.F.; Szluha, A.T. (Oak Ridge National Lab., TN (USA)). 1978. Contract W-7405-ENG-26. 53p. Dep. NTIS, PC A04/MF A01.
From International symposium on the environmental effects of hydraulic engineering works; Knoxville, TN, USA (12 Sep 1978).
A preliminary survey of fish protection devices either in use or proposed for water intake structures was conducted for the purpose of assessing their potential for reducing impingement and entrainment. All the designs examined can be divided into two basic categories: behavioral screening systems and physical screening systems. The behavioral screening devices rely upon the ability of fish to sense artificial stimuli and respond by swimming away from hazardous areas. These

systems are of little or no value in protecting planktonic fish eggs, larvae, and disoriented, heat-shocked, or lethargic adult fishes. Many of the physical screening devices, on the other hand, require the impingement of organisms against a screen before they can be removed from the intake system, thus subjecting survival. Some of the designs incorporate both behavioral and physical sceening concepts. Six devices were selected for further consideration based on their potential or demonstrated effectiveness in reducing impingement and entrainment losses at a variety of intake situations. The structures evaluated were modified vertical traveling screens, louvers, angled vertical traveling screens, horizontal traveling screens, center-flow screens, and wedge-wire screens. Since some of these intake structures represent new concepts, few laboratory or in situ biological studies have been carried out. For others, actual reductions in fish losses have been demonstrated. The design features and status of biological testing is discussed for each device, and an evaluation of their fish protection potential is presented.

43 (CONF-7811108--1) OXIDANT EFFECTS ON COMPLEX MIXTURES OF NONVOLATILE ORGANICS IN POLLUTED WATERS: EXAMINATION BY HPLC AND BIOSCREENING. Jolley, R.L.; Cumming, R.B. (Oak Ridge National Lab., TN (USA)). 1978. Contract W-7405-ENG-26. 21p. Dep. NTIS, PC A02/MF A01.

From 2. aquatic application of ozone workshop; Orlando, FL, USA (1 Nov 1978).

Chemical oxidants such as ozone and chlorine are used for antifoulant treatment of cooling waters and disinfection of polluted waters. The effects of these oxidants on the nonvolatile organic constituents in such waters are being examined using the complementary techniques of high-pressure liquid chromatography (HPLC) and bioscreening. HPLC is used to separate the nonvolatile organic constituents present in complex mixtures in the waters of environmental concern, and the separated organics are detected by UV absorbance or cerate oxidimetry. Bioscreening tests are used to facilitate the examination of only those separated constituents with biological and possible health significance. The bioscreening method principally used is determination of bacterial mutagenic activity. Both ozone and chlorine destroy some nonvolatile organic constituents and produce others. To date, no statistically significant mutagenic activity has been determined for constituents separated from ozonated effluents from wastewater treatment plants.

44 (COO--2502-15) THERMOREGULATION OF FISH AND TURTLES IN THERMALLY STRESSED HABITATS. ANNUAL PROGRESS REPORT, OCTOBER 1, 1977--SEPTEMBER 30, 1978. Spotila, J.R. (State Univ. Coll., Buffalo, NY (USA)). Jun 1978. Contract EY-76-S-02-2502. 26p. Dep. NTIS, PC A03/MF A01.

Morphometric and heating and cooling studies on over 100 largemouth bass, Micropterus salmoides, have provided the data needed to refine the time-dependent body temperature model for fish. The model can now track the changes in body temperature of a bass if its weight and water temperature are known. The model is most sensitive to body diameter, body wall thickness, and tissue conductivity. Doubling tissue conductivity is equivalent to decreasing body diameter by a factor or two. Turtles, Chrysemys scripta, living in the heated portion of a cooling reservoir facultatively exploit the warmed water (ΔT = 4 to 10°C) as an auxiliary heat source for behavioral thermoregulation. Turtles in the heated arm of PAR pond have a smaller home range (200 m) than turtles in an ambient portion of the reservoir (507 m). The ability of animals to thermoregulate at a high constant body temperature depends upon the constraints imposed on them by their body size and physical characteristics and those of their environment. The net heat production required to maintain a specific body temperature changes as the size of an ectotherm increases. Operative environmental temperature is an appropriate measure of environmental heat loading and can be used as a predictor of turtle behavior. This concept may become very valuable in quantifying the effect of thermal effluents on turtle and fish behavior.

45 (COO--2502-16) CONTINUATION OF STUDIES ON THERMOREGULATION OF FISH AND TURTLES IN THERMALLY STRESSED HABITATS. ANNUAL PROGRESS REPORT, 1 OCTOBER 1978-30 SEPTEMBER 1979. Spotila, J.R. (State Univ. Coll., Buffalo, NY (USA)). Jun 1979. Contract EY-76-S-02-2502. 33p. Dep. NTIS, PC A03/MF A01.

A time dependent mathematical model accurately predicts heart, brain, and gut temperatures of largemouth bass. Body diameter, insulation thickness, and tissue thermal conductivity are controlling variables in the transfer of heat between a fish and water. Fish metabolic rate and water velocity across fish surfaces do not appreciably affect heat transfer rates. Multichannel temperature transmitters telemeter body temperatures of free swimming bass in Pond C on the Savannah River Plant while the behavior of those fish and other bass is recorded by an observer. Field studies of the home ranges and movements of turtles in Par Pond on the Savannah River Plant are completed. We have recorded the movements of 30 individuals fitted with radio transmitters. Distinct differences are apparent in the behavior of turtles in areas affected by heated effluents as compared to those in control areas. Calculations and theoretical analysis of the transient energy exchange of turtles are continuing. Laboratory experiments using ^{133}Xe indicate that blood flow in the muscles and skin of alligators increases 2 to 6 fold during movement. Relative variation is similar in magnitude to that seen in human muscle. Evaporative water loss from alligators decreases as body size increases. The ratios of respiratory to cutaneous water loss are 1.80 at 5°C, 1.18 at 25°C and 0.85 at 35°C. Boundary layer resistances to evaporative water loss are 6 fold less than predicted by calculations of aerodynamic boundary layers. Body size is a primary factor in determining the thermoregulatory strategy that is to be used by a given animal.Operative environmental temperatures (T/sub e/) are as high as 60°C for a turtle basking on a log in the sun. In a rainstorm T/sub e/ drops to 18°C. Experiments to measure T/sub e/ for turtles in normal and thermally affected areas are now continuing on the Savannah River Plant. (ERB)

46 (COO--4051-16) GEOTHERMAL POWER PLANTS OF JAPAN: A TECHNICAL SURVEY OF EXISTING AND PLANNED INSTALLATIONS. REPORT NO. CATMEC/9. DiPippo, R. (Brown Univ., Providence, RI (USA). Div. of Engineering). Mar 1978. Contract EY-76-S-02-4051. 93p. Dep. NTIS, PC A05/MF A01.

The technical features of the existing and planned geothermal power plants in Japan are surveyed. A description is given of the Geothermal Energy Research and Development Co., Ltd. (GERD) which has capabilities in all areas

of geothermal power development, from exploratory geological activities through construction and operation of the plants. The survey includes reports on four types of plants: natural, dry steam; separated steam or "single flash;" separated steam/flash or "double flash;" and binary fluid. For each geothermal power plant, the following are included or discussed: exploration and geology of the site; wells and gathering system; turbine-generator; condenser, gas extractor and cooling tower; economic data; environmental effects; and plant operations. Many tables and figures are included, and a summary is given of the geothermal resource utilization efficiency for each operating plant. Promising areas of new development are listed with estimates of potential capacity.

47 (COO--4218-1) CONCEPTUAL DESIGN AND COST EVALUATION OF A HIGH PERFORMANCE DRY COOLING SYSTEM. Haterski, R.J.; Bentz, J.C. (Curtiss-Wright Corp., Wood-Ridge, NJ (USA)). 1 Mar 1978. Contract EN-77-C-02-4218. 144p. (CWC-WR--78-001). Dep. NTIS MF/A 01.

Portions of document are illegible.

The objectives of this program were to establish a conceptual and preliminary design of a forced draft dry cooling system using high performance integral fin-tubes developed by Curtiss-Wright and to establish projected costs of this system for use in large electric power plants. These investigations are an extension of a previous study, which showed that significant performance and cost savings were potentially available with the use of these advanced technology integral fin-tube heat transfer elements when used in forced or induced draft dry cooling towers. An attempt is made to delineate and quantify these potential cost savings and to investigate further the installation factors associated with the use of these fin-tubes in a dry cooling system. The results obtained show significant economic advantages compared to results previously published for a conventional dry cooling system. These advantages are due to the higher heat transfer and lower pressure loss which occur with the use of the selected multi-port integral fin-tubes.

48 (COO--4218-2) CONCEPTUAL DESIGNS AND COST ESTIMATES OF MECHANICAL DRAFT WET/DRY AND NATURAL DRAFT DRY COOLING SYSTEMS USING CURTISS-WRIGHT INTEGRAL FIN-TUBE HEAT EXCHANGERS. Haberski, R.J.; Bentz, J.C. (Curtiss-Wright Corp., Wood-Ridge, NJ (USA). Nuclear Div.). Apr 1979. Contract EN-77-C-02-4218. 107p. (CW-WR--79-010). Dep. NTIS, PC A06/MF A01.

This study was performed to establish a conceptual design and cost evaluation of an advanced technology mechanical draft wet/dry and natural draft dry cooling systems for large electric power plants using a high performance integral fin-tube heat transfer surface. This study was part of an overall DOE program to develop and demonstrate advanced concept cooling systems for large electric power plants. The results obtained show significant economic advantages compared to results previously published for conventional cooling systems. These advantages are due to the higher heat transfer and lower pressure loss which occur with the use of the selected multi-port integral fin-tubes.

49 (COO--4531-3) EFFECT OF ALTERNATE COOLING SYSTEMS AND BENEFICIAL USE OF WASTE HEAT ON POWER PLANT PERFORMANCE. Rao, D.K.; Porter, R.W. (Illinois Inst. of Tech., Chicago (USA). Dept. of Mechanical Engineering). Nov 1978. Contract EC-77-S-02-4531. 123p. Dep. NTIS, PC A06/MF A01.

The performance and cost of alternate closed-cycle cooling systems for steam--electric power plants are discussed. Included are cooling ponds, spray canals and mechanical- and natural-draft wet cooling towers. Besides equipment, operational and maintenance costs, loss of generating capacity is determined on a seasonal basis in order to determine life-cycle costs relative to once-through cooling. In addition, two beneficial uses of waste heat are similarly analyzed: once-through discharge of condenser coolant into a municipal water supply and interaction of a conventional cooling system with a wastewater treatment plant. Both typical nuclear- and fossil-fueled power plants are considered throughout. Meteorological and system parameters were taken for the Chicago area as an example. Plant heat rates, availability and unit costs were selected from the literature. A new unified analysis of closed-cycle-cooling system performance is developed in order to facilitate computation of loss of generating capacity. The order of cooling systems in terms of increasing cost is: once-through, pond, natural-draft wet tower, spray canal and mechanical-draft wet tower. Alternatively, once-through discharge into a municipal water supply would save 1 to 2% of power-plant fuel and 14 to 22% of residential water-heater energy. Or, the interactive wastewater plant would save 2 to 15% of treatment costs, favoring larger facilities.

50 (DFVLR-IB--553-75/15) PHYSICAL QUANTITIES RELATED TO MEASUREMENT CAMPAIGNS FOR COOLING TOWERS. Boegel, W. (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt e.V., Oberpfaffenhofen (Germany, F.R.). Inst. fuer Physik der Atmosphaere). Dec 1975. 29p. (In German). Dep. NTIS (US Sales Only), PC A03/MF A01.

The nomenclature in reports on the measurement campaigns for cooling towers will be adapted as far as possible to the already existing VDI report on this subject. On the other hand, the appropriate standards will also be accounted for. In order to facilitate a decision in individual cases in a first table the meteorologically or generally interesting quantities of the VDI reports are compared with the German, international, and WMO standards and - if necessary - also commented. A second table contains the air humidity parameters standardized by WMO including brief definitions.

51 (DOE/ET--0076, pp 11p, App.C) RAZDAN (RASDAN) THERMAL POWER STATION. Feb 1979.

Report of the visit of the United States of America delegation of the US-USSR Coordinating Committee on Scientific and Technical Cooperation in the Field of Thermal Power Plant Heat Rejection Systems to the Union of Soviet Socialist Republics. November 11--12, 1978.

Technical data on the design and operation of the gas or oil-fueled Rasdan heat-and-power plant in Armenia are presented. This 1220 mW capacity plant has a dry cooling tower for each of its four turbines. The last unit was put in operation in 1970. Specifications for the overall plant, condensing system, turbogenerators, electrical equipment, control equipment, and water treatment plant are included. (LCL)

52 (DOE/ET--0076, pp 17p, App.B Paper 5) SYSTEM OF HEAT REMOVAL FOR AN ELECTRIC POWER STATION LOCATED IN A DRY SUBTROPICAL CLIMATE. Kravets, V.I.; Radionov, N.I. Feb 1979.

Report of the visit of the United States of America delegation of the US-USSR Coordinating Committee on Scientific and Technical Cooperation in the Field of Thermal Power Plant Heat Rejection Systems to the Union of Soviet Socialist Republics. November 11--12, 1978.

Cooling systems for power plants in hot dry climates pose special problems due to limited water supplies and high ambient air temperatures. The design of a combined air-condensation cooling system planned for the 600 MW oil-fueled Isfahan power plant in Iran is described. This system combines dry cooling towers with peak coolers and can operate in the dry cooling mode, in a transitional mode with part dry and part condensation, or completely in the peak mode with the irrigated coolers. Calculations made for the Isfahan power plant showed that this combined air-condensation cooling system would provide the necessary temperature for steam condensation and heat removal at nominal turbine output and would require extremely low water use. (LCL)

53 (DOE/ET--0076, pp 29p, App.A Paper 2) TECHNICAL AND ECONOMIC FEASIBILITIES OF WET/DRY TOWER SYSTEMS FOR WATER CONSERVATION. Englesson, G.A. (United Engineers and Constructors Inc., Philadelphia, PA); Hu, M.C.; Savage, W.F. Feb 1979.

Report of the visit of the United States of America delegation of the US-USSR Coordinating Committee on Scientific and Technical Cooperation in the Field of Thermal Power Plant Heat Rejection Systems to the Union of Soviet Socialist Republics. November 11--12, 1978.

The technical and economic feasibility of wet/dry cooling towers for water conservation was evaluated. Results on economic optimization of wet/dry tower systems for 1000-MWe power plants are presented. Results are given as the Total Evaluated Cost (TEC) of the cooling system. Separate cost components include initial capital cost, operating expenses, and penalties for the cooling system operation capitalized over the lifetime of the plants. For the analysis, optimized wet and dry cooling towers are the reference systems. The wet/dry system has separate wet and dry mechanical draft towers. Costs are related to the make-up requirement expressed as a percentage of the water required by a wet system. The major conclusions are: wet/dry cooling tower systems can be designed to provide a significant economic advantage over dry cooling, yet closely match the dry tower's ability to conserve water; and where water is available, wet cooling will continue to be the economic choice in most circumstances.

54 (DOE/ET--0076, pp 32p, App.A Paper 3) COMPARATIVE COST STUDY OF VARIOUS WET/DRY COOLING CONCEPTS THAT USE AMMONIA AS THE INTERMEDIATE HEAT EXCHANGE FLUID. Johnson, B.M.; Tokarz, R.D.; Braun, D.J.; Allemann, R.T. (Battelle, Pacific Northwest Laboratory, Richland, WA). Feb 1979.

Report of the visit of the United States of America delegation of the US-USSR Coordinating Committee on Scientific and Technical Cooperation in the Field of Thermal ower Plant Heat Rejection Systems to the Union of Soviet Socialist Republics. November 11--12, 1978.

A number of advanced concepts for wet-dry cooling systems for power generating plants were studied for their technical feasibility and economic potential. The use of ammonia as a heat transfer medium between the steam condenser of the generator turbine and the air-cooled heat rejection system has been shown to be cost effective in earlier studies. This paper summarizes the conceptual design and costs of four different advanced dry/wet mechanical draft concepts, which combine the use of ammonia with evaporative cooling to augment capacity on hot days, and compares them to a state-of-the-art integrated dry/wet circulating water system. The four concepts utilizing ammonia are: the HOTERV plate fin heat exchanger with deluge augmented cooling arranged in (a) vertical stacks on the periphery of circular towers, and (b) horizontal A-frames beneath the fans; the separate channel augmented tower (SCAT); and the augmenting ammonia condenser (AAC) arrangement. These are compared with the integrated dry-wet tower currently being constructed at the San Juan site at Farmington, NM. The results of this study indicate that the ammonia dry cooling systems, augmented either by deluging the surface or by a separate water-cooled condenser close-coupled to an evaporative tower, have potential cost advantages ranging from 25 to 29% under conditions imposed by the San Juan site. A program to demonstrate an ammonia dry cooling system, using both types of surface described here, and using both the deluge approach and the augmented condenser, is being undertaken by the Electric Power Research Institute.

55 (DOE/ET--0076, pp 17p, App. A Paper 7) STATUS REPORT ON THE AMMONIA, PHASE-CHANGE DRY COOLING SYSTEM RESEARCH PROJECT. Bartz, J.A.; Maulbetsch, J.S.;. (Electric Power Research Institute, Palo Alto, CA). Feb 1979.

Report of the visit of the United States of America delegation of the US-USSR Coordinating Committee on Scientific and Technical Cooperation in the Field of Thermal Power Plant Heat Rejection Systems to the Union of Soviet Socialist Republics. November 11--12, 1978.

Previous research, supported by the US Department of Energy (DOE) and the Electric Power Research Institute, has identified the ammonia-based dry cooling system as the most promising approach to water conservation in power plant cooling for utilities. The system configuration which has been selected as optimum in these studies will now be demonstrated on a 6 Mwe test facility at a Pacific Gas and Electric power plant in Bakersfield, California. The demonstration will include the use of ammonia in the transport loop, the use of enhanced heat transfer surfaces in the steam condenser/ammonia reboiler, and the use of deluge water augmentation on the air-cooled condenser in addition to all-dry operation. The facility will be designed and constructed during 1979 and 1980. Testing is scheduled after 1980 through 1984. In addition to component performance data, the test program will emphasize: the effect of the power plant environment on the component performance and reliability; reliability of proposed fabrication techniques for the aluminum components; and dynamic responses of the system to power plant operating transients and to emergency conditions.

56 (DOE/ET--0076, pp 31p, App.A Paper 6) METEOROLOGICAL EFFECTS OF HEAT AND MOISTURE RELEASES FROM LARGE POWER STATIONS (PRECIPITATION MODIFICATION). Patrinos, A.A.N.; Eissenberg, D.M. (Oak Ridge National Laboratory, TN). Feb 1979.

Report of the visit of the United States of America delegation of the US-USSR Coordinating Committee on Scientific and Technical Cooperation in the Field of Thermal Power Plant Heat Rejection Systems to the Union of Soviet Socialist Republics. November 11--12, 1978.

The US Department of Energy (DOE) has

established a program called METER (Meteorological Effects of Thermal Energy Releases) to investigate the atmospheric effects of cooling towers and ponds. Effects being investigated include drift deposition, fog and icing, shadowing, and precipitation modification. As part of this nationwide program, the Oak Ridge National Laboratory (ORNL) is studying precipitation modification from large cooling towers. For that purpose, the Bowen Electric Generating Plant (Plant Bowen) in Northwest Georgia has been chosen as a test site. This 3,200-MWe coal-fired power plant situated about 40 mi NW of the city of Atlanta uses four natural-draft cooling towers and is the largest of US power plants having cooling towers as the sole cooling method. The ORNL activities which presently include both climatological and field studies are described. Extensive use has been made of the US National Weather Service (NWS) data accumulated over several decades in Northwest Georgia. Apart from providing preliminary indications of precipitation modification effects, these data have aided in the general understanding of the climatology in the vicinity of Plant Bowen and have paved the way for the field studies currently underway. These field studies, employing a dense network of rain gauges and windsets, are expected to provide the statistical data base necessary to estimate the plant's effect (if any) on precipitation.

57 (DOE/ET--0078, pp 14p, App.A Paper 10) COMPUTERIZED SYSTEM FOR ESTIMATING WATER AVAILABILITY AND REQUIREMENTS FOR POWER PLANT COOLING. Savage, W.F. (Department of Energy, Washington, DC); Sonnichsen, J.C. Jr. Feb 1979.

Report of the visit of the United States of America delegation of the US-USSR Coordinating Committee on Scientific and Technical Cooperation in the Field of Thermal Power Plant Heat Rejection Systems to the Union of Soviet Socialist Republics. November 11--12, 1978.

As a means of assimilating the immense data base which exists on water resources characteristics and availability, a computerized system has been developed. The system was designed primarily to assist the individual engaged in siting thermal power plants; however, the utility of the system is much more general. Characteristic type data on both surface water and ground water sources are inluded in the system. The data are organized around the use of an eight digit water resource cataloging unit to represent a surface area which is a natural hydrologic drainage basin. By using the water resources cataloging unit, the surface of the US is sub-divided into more than 2000 areas. The water resource cataloging unit is used to index all water resources and power plant data contained in the information retrieval system. Furthermore, the water resource cataloging unit is used as an indexing scheme for correlating water demand. This data bank and its use for determining cooling water demands for proposed power plants are discussed. (LCL)

58 (DOE/EV--0046(Vol.3), pp 6-16) OVERVIEW OF H_2S CONTROL TECHNOLOGY FOR GEOTHERMAL ENERGY SOURCES. Ananth, K.P. (Midwest Research Inst., Kansas City, MO). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

The control of H_2S emissions from geothermal power plants is discussed briefly. The control options, as presented here, are primarily directed toward: (1) incoming steam (i.e., upstream), (2) condenser vent emissions, and (3) cooling tower emissions. For each category, the major processes are identified along with their advantages and disadvantages. Finally, the processes are intercompared using several selection criteria. These criteria include stage of development of the control technology, its potential for H_2S removal, extent of applicability, cost of control, and secondary environmental problems created, if any.

59 (DOE/EV--0046(Vol.3), pp 332-349) OVERVIEW OF THE DEPARTMENT OF ENERGY'S METEOROLOGICAL EFFECTS OF THERMAL ENERGY RELEASES (METER) PROGRAM. Rubin, A.M. (Dept. of Energy, Washington, DC); Moses, H.; Eissenberg, D. Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

The objective of the Meteorological Effects of Thermal Energy Releases (METER) Program is to develop methods and a data base to assess the atmospheric effects of heat and moisture releases from large nuclear and fossil energy generating facilities. Included in the program are effects from mechanical and natural draft cooling towers, as well as cooling ponds and canals. The atmospheric effects which are of interest include precipitation modification, fogging and icing, multiple plume interactions, drift deposition, shadowing, and others. The METER program is subdivided into three coordinated elements: (1) field studies, (2) physical modeling, and (3) mathematical modeling. Current studies are primarily directed towards field studies at operating plants. ORNL is carrying out a statistical precipitation study over a several year period at the 3160 MWe Bowen plant in Georgia utilizing a dense raingage network around the plant to determine to what extent normal rainfall patterns are affected by thermal emissions from natural draft cooling towers. A second field study, by PNL, deals with drift deposition and transport from mechanical draft cooling towers. Penn State University is conducting airborne measurements of velocity, temperature, and drift within plumes from a natural draft tower. ANL is conducting a study of the effects of cooling ponds on the environment. In the area of mathematical modeling, the Rand Corporation is conducting numerical model studies to provide a better understanding of the effects on weather phenomena from cooling tower heat releases. PNL is conducting physical model experiments of mechanical draft cooling towers in order to better understand the phenomena of plume interactions between adjacent cooling towers.

60 (DOE/EV--0046(Vol.3), pp 380-411) ACCOMPLISHMENTS IN THE DEPARTMENT OF ENERGY PROGRAM ON ADVANCED CONCEPTS FOR DRY AND DRY/WET COOLING. Johnson, B.M. (Battelle Pacific Northwest Labs., Richland, WA). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

The Dry Cooling Enhancement Program has focused on the development of technology and the initial planning for a large-scale test of an advanced dry/wet cooling concept. The overall program objective is to develop technology to relieve the water shortage anticipated in many sections of the country through encouraging the use of dry cooling of power plants. The development of systems which are less costly, with respect to operating penalties as well as capital, and the transfer of this technology to the commercial market were seen to be essential in order to have any impact on the national problem of growing competition for existing water supplies. The system selected for large scale testing is one

which uses ammonia to transfer the waste heat from the turbine to a dry cooling tower and is enhanced by two different ways of incorporating evaporative cooling. One uses a conventional cooling tower close coupled to a water-cooled ammonia condenser, the other uses water evaporated from the surface of the dry tower over which it flows. The five areas of the total DOE program are discussed and include: studies of the anticipated need for dry cooling and the payoff from a successful demonstration of an improved system; evaluation of existing technology to identify areas in which improvements would have major impact; identification of improved systems and the comparisons of projected costs to establish the incentives for further development and large scale testing; testing of critical aspects of the system selected as the leading candidate for large-scale testing; and development of a concensus among various elements of the utility industry as to the wisdom of proceeding with a large scale test and the structuring of a program and a funding base to carry out the test.

61 (DOE/EV--0046(Vol.3), pp 412-429) WASTE HEAT MANAGEMENT IN THE ELECTRIC POWER INDUSTRY: ISSUES OF ENERGY CONSERVATION AND STATION OPERATION UNDER ENVIRONMENTAL CONSTRAINTS. Herleman, D.R.F.; Stolzenbach, K.D.; Glicksman, L.R.; Adams, E.E.; Barbera, R.J. (Massachusetts Inst. of Tech., Cambridge). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

The issues of cost, conversion efficiency and environmental impacts associated with the condenser cooling systems of large steam-electric power plants are discussed. Emphasis is placed on several alternatives to the use of conventional open cycle cooling or wet cooling towers. Particular issues which have been addressed include the effect of replacement energy costs on optimal cooling system size (especially for dry towers), the development of a quasi-steady representation of the transient response of cooling systems with large thermal inertia (e.g., cooling ponds), and the effect of stream standards on the operation and penalty costs of supplementary cooling systems. Furthermore, various cooling systems have been compared at a hypothetical site and the results have been used, along with the data on cooling water availability, to deduce conclusions regarding differences in cooling costs which result from varying environmental controls.

62 (DOE/EV--0046(Vol.3), pp 430-451) SUPPORTING STUDIES IN HEAT DISSIPATION. Helms, I. (Dept. of Energy, Washington, DC); Haberski, R.J.; Bentz, J.C.; Sonnichsen, J.L.; Moore, F. Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

Three studies in support of the DOE heat dissipation effort are described. A study of an improved heat transfer surface by Curtiss-Wright has shown substantially less cost for dry cooling towers; a power plant water data information system at REDL is described, and the Cornell University program on cooling tower wind effects is discussed, together with some possible modifications which may have less wind effect.

63 (DOE/EV/00900--5) IMPACT OF THERMAL LOADING AND OTHER WATER QUALITY PARAMETERS ON THE EPIZOOTICLOGY OF AEROMONAS HYDROPHILA INFECTIONS OF CENTRARCHIDS. Esch, G.W.; Hazen, T.C. (Wake Forest Univ., Winston-Salem, NC (USA). Dept. of Biology). 1979. Contract EY-76-S-09-0900. 17p. Dep. NTIS, PC A02/MF A01.

During the current contract year, the following results were obtained: (1) Data from field-generated studies have shown that hematocrit, hemoglobin, total red blood cell counts, total white blood cell counts, and cortisol levels are significantly affected in largemouth bass with body conditions < 2.0, suggesting that stress, body condition, and the probability of bass acquiring red-sore disease are related. Laboratory studies appear to at least partially confirm these results. (2) Chemotaxis studies show that Aeromonas hydrophila is attracted to specific sugars and amino acids and that there appears to be a strain-related affect of fish mucous on A. hydrophila isolated from red-sore lesions. (3) Immunologic and serologic tests suggest that A. hydrophila isolated from red-sore lesions on bass from one lake system will not cross-react with antibodies in sera isolated from bass in another lake system, suggesting the existence of different strains in different lakes.

64 (DOE/NASA/CR--150674) PRELIMINARY DESIGN PACKAGE FOR SOLAR HEATING AND COOLING SYSTEMS. (AiResearch Mfg. Co., Torrance, CA (USA)). May 1978. Contract EX-76-A-29-1037. 182p. Dep. NTIS, MF A01.

Portions of document are illegible.

Summarized preliminary design information on AiResearch Manufacturing Company activities associated with the development, delivery and support of solar heating and cooling systems is presented. These systems are for single family dwellings and commercial applications. The AiResearch approach to the heating/cooling systems is to use a reversible vapor compression heat pump that is driven in the cooling mode by a Rankine power loop, and in the heating mode by a variable speed electric motor. The heating/cooling systems differ from the heating-only systems in the arrangement of the heat pump subsystem and the addition of a cooling tower to provide the heat sink for cooling mode operation.

65 (DOE/TIC--10136) ANALYSIS OF THE VALIDITY OF THE UTILITIES STOCK-RECRUITMENT CURVE-FITTING EXERCISE. Christensen, S.W.; Goodyear, C.P.; Kirk, B.L. (Oak Ridge National Lab., TN (USA); Fish and Wildlife Service, Ann Arbor, MI (USA)). May 1979. Contract W-7405-ENG-26. 316p. Dep. NTIS, PC A14/MF A01.

An analysis was made of the validity of the stock-recruitment curve-fitting exercise used to quantify the consequences of power plant operation on the striped bass population of the Hudson River. The use of a particular stock-recruitment model, called the Ricker model (Ricker 1954, 1958, and 1974), forms a cornerstone of the utilities' case. Based on estimates of a parameter termed ''alpha'' in the Ricker model, estimates of annual entrainment and impingement impacts of the Hudson River power plants on young-of-the-year striped bass are converted to estimates of long-term reduction in the equilibrium population size of adult striped bass. Results of the analysis of the exercise indicate that it is not valid.

66 (DP--1489, pp 105-109) GENETIC VARIABILITY OF E. COLI IN SOUTHEASTERN RESERVOIRS. Kasweck, K.L.; Fliermans, C.B. Oct 1978.

Savannah River Laboratory environmental transport and effects research. Annual

report, 1977.

The data indicate that there is an emergence of a lactose negative population in chambers containing a predominately lactose positive population when that population is subjected to conditions peculiar to the heated effluent from a nuclear production reactor. The effect is more than a temperature phenomenon, because E. coli colonies placed in chambers subjected to similar temperatures in other natural systems did not vary in their lactose utilization characteristics. Additionally, chambers placed in deeper cooler waters varied in their lactose characteristic but to a slower degree than the overlying epilimnion waters. Regardless of the cause of the lactose change, the result is that standard methods do not easily detect or quantitate E. coli in Par Pond waters. The assessment of water quality based on fecal coliform measurements in lakes similar to Par Pond would result in data that would indicate that the water quality of such lakes is better than it really is.

67 (DP--1489, pp 93-96) PAR POND CIRCULATION PATTERNS AND PLANKTON SAMPLING. Vigerstad, T.J.; Kiser, D.L. Oct 1978.

Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

Circulatory patterns in a cooling reservoir in the vicinity of a hot water discharge can influence the temperatures experienced by biota in the reservoir. Sampling of Cladocera and subsequent dye studies in the Hot Arm of Par Pond (a cooling reservoir for nuclear reactor water on the Savannah River Plant) indicate that reactor effluents can be expected to transport biota from the limnetic portion of the lake in the vicinity of the effluent discharge to areas farther down the effluent-receiving-arm or to the littoral zone. This transport can confound sampling programs and complicate attempts to describe the thermal history of organisms.

68 (DP--1489, pp 99-103) ELEMENTAL GRADIENTS IN MACROPHYTES FROM A REACTOR EFFLUENT GRADIENT. Grace, J.B.; Tilly, L.J. Oct 1978.

Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

The tissues of submersed macrophtes from along the thermal gradient were analyzed for phosphorus to determine whether any pattern corresponded to standing crop distributions could be detected. Although water concentrations of phosphorus showed no detectable relationship to the thermal effluent, tissue concentrations of this element in submersed macrophytes declined with distance from the effluent entry point. The occurrence of this concentration pattern suggests that phosphorus availability is greater near the discharge. Because phosphorus is the element most often determined to limit aquatic productivity, its greater availability may partially account for the apparent enhancement of macrophte growth near the thermal discharge. A patter of macrophyte abundance which indicated enchancement related to the discharge gradient in the reactor-cooling reservoir, Par Pond is reported. Correlative data tended to implicate light and temperature as important in influencing the differential abundance pattern.

69 (DP--1489, pp 115-119) TEN-MONTH RECOLONIZATION OF THE K-AREA COOLING WATER SYSTEM BY THE ASIATIC CLAM CORBICULA FLUMINEA. Harvey, R.S. Oct 1978.

Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

The Asiatic clam Corbicula fluminea was found in the Savannah River near Augusta, Georgia, in 1973. In 1975, Corbicula clogged heat exchangers and caused a shutdown of P Reactor, one of three operating nuclear production reactors (P, K, and C) at the Savannah River Plant (SRP). Clams were subsequently removed from K-Area and C-Area cooling water systems. At K Area, large volumes of river water are discharged into three 23-megaliter basins (Figure 1) where some settling occurs before the water is pumped through heat exchangers in the reactor area. The deposited silt provides a suitable substrate for Corbicula growth and reproduction. The silt must be removed at regular inervals to prevent heat exchanger pluggage arising from high populations of clams in the basins. The 186 basins at K Area were sampled to determine: the buildup of the Corbicula population since the basins were last cleaned, the size/age distribution of the clam population, and the occurrence of clam larvae. In addition, debris from flushes of Emergency Cooling Water Headers CW-39 and RW-1 were analyzed to determine: the relative abundance of live and dead clams, the size/age distribution of clams, and the volume of individual debris components.

70 (DP--1489, pp 121-122) IMPINGEMENT OF JUVENILE AND ADULT FISHES DURING COOLING WATER WITHDRAWAL. McFarlane, R.W. Oct 1978.

Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

Juvenile and adult fishes are impinged upon trash removal screens as Savannah River water is withdrawn for use on the Savannah River Plant (SRP). Thirty-six species of fish, representing half of all riverine species known from the area, were impinged on the screens at three SRP pumping stations during 1977. Based on the average of 11.2 fish impinged per day, annual impingement is estimated to be 4088 fish. SRP thus ranks third lowest for impingement recently reported for 33 electric power plants.

71 (DP--1489, pp 123-124) ENTRAINMENT OF ICHTHYOPLANKTON AND LARVAL FISHES DURING COOLING WATER WITHDRAWAL. McFarlane, R.W. Oct 1978.

Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

Plantonic fish eggs and larvae are entrained into the Savannah River Plant (SRP) pumping system as Savannah River water is withdrawn for cooling purposes. The American shad contributed 96% of the planktonic fish eggs collected in the Savannah River. Eggs were rare in plankton samples from the intake canals and were assumed to have settled to the bottom as current velocity was reduced in the canal entrance. An estimated 72 million fish eggs were transported past the intake canals. Assuming ''worst case conditions,'' 6.8 million eggs (9.5%) could have been lost due to entrainment. Blueback herring comprised nearly one-half of the 216 million fish larvae susceptible to impact. Spotted sucker and black crappie were also common among the 22 species of fish larvae collected. An estimated 19.6 million (9.1%) fish larvae could have been entrained under ''worst case conditions''.

72 (DP--1489, pp 129-132) BACTERIAL PATHOGENS IN A REACTOR COOLING RESERVOIR.

Kasweck, K.L. (Florida Inst. of Tech., Melbourne); Fliermans, C.B. Oct 1978.

Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

The results of the sampling in both Par Pond and Clark Hill Reservoir are given. The frequency of isolation is a qualitative parameter which indicates how often the specified bacterium was isolated from each habitat. Initial scoping experiments demonstrated that a wider variety of pathogenic bacteria occur in Par Pond than in Clark Hill Reservoir. Such findings are interesting because Par Pond does not receive any human wastes directly, yet bacteria generally associated with human wastes are more frequently isolated from Par Pond. Previous studies have demonstrated that certain non-spore-forming enteric bacteria do not survive the intense heat associated with the cooling water when the reactor is operating. However, even when the reactor is not operating, cooling water, consisting of 10% makeup water from Savannah River, continues to flow into Par Pond. This flow provides a source of bacteria which inoculate Par Pond. Once the reactor is again operating, these same bacteria appear to be able to survive and grow within the Par Pond system. Thus, Par Pond and the associated lakes and canals of the Par Pond system provide a pool of pathogens that normally would not survive in natural waters.

73 (EPA--600/7-78-168, pp 147-152) ASSESSMENT OF ATMOSPHERIC EMISSIONS FROM PETROLEUM REFINING. Rosebrook, D.D.; Wetherold, R.G.; Harris, G.E. (Radian Corp., Austin, TX). Aug 1978.

From Symposium on process measurements for environmental assessment; Atlanta, GA, USA (13 Feb 1978).

A study, funded by the U.S. EPA, is currently being conducted in order to assess the atmospheric emissions from petroleum refining operations. To accomplish this assessment measurements of fugitive hydrocarbon and stack emissions are being made at a number of refineries throughout the country. Sources being sampled include valves, flanges, pumps and compressor seals process drains, pressure relief devices, process vents, heater and process stacks, cooling towers, API separators, dissolved-flotation units, open ditches, barometric sumps and holding ponds. This paper describes the methods being employed for the selection and screening of the above sources and the criteria used for making the sample - no sample decision.

74 (EPRI-EA--886-SR) MODIFICATION OF LOCAL WEATHER BY POWER PLANT OPERATION. FINAL REPORT. Laurmann, J. (Stanford Univ., CA (USA)). Aug 1978. 17p. Dep. NTIS, PC A02/MF A01.

Power plant operation can affect weather as a result of emissions of effluents and from release of waste heat. Effluents can cause acid rain and impaired visibility. The release of waste heat can affect weather by changing local meteorology in a manner which stimulates an otherwise inactive convective instability. In general, however, the energy from waste heat from a conventional power plant is far less than that needed to trigger such events as thunderstorms or cyclones. Large power perks (upwards of 10,000 MWe), however, do have the potential for causing thunderstorms. Small power plants have an energy output comparable to that of a tornado but the heat rise is too buoyant to develop the vorticity needed for tornadoes. Much research is needed in gathering field data and in developing three-dimensional models for describing latent atmospheric instabilities. In view of the low probability of conventional power plants causing significant weather changes, and in view of the comprehensive research program on inadvertent weather modification by the Department of Energy, no additional EPRI research effort is needed at this time.

75 (EPRI-EA--901) USER'S GUIDE TO AN ENVIRONMENTAL INFORMATION RESOURCE FOR THERMAL POWER STATION COOLING SYSTEMS. Hannon, E.H.; Pfuderer, H.A. (Atomic Industrial Forum, Inc., Washington, DC (USA); Oak Ridge National Lab., TN (USA)). Sep 1978. 51p. Dep. NTIS, PC A04/MF A01.

A bibliographic computerized data base of data and literature related to cooling system impacts on aquatic environments has been compiled under contract to the Electric Power Research Institute by the Information Center Complex at Oak Ridge National Laboratory (ORNL) and the Atomic Industrial Forum, Inc. (AIF). The data base covers four major subject areas: thermal effects, chemical effects, impingement, and entrainment. The ORNL portion of the project covers existing "open" or published literature, including government and university reports, conference proceedings, trade journals, etc. The AIF portion covers previously inaccessible, "gray" literature and data contained in utility environmental reports, impact statements, Section 316(a) and (b) demonstrations, stage agency water quality reports, in-house studies, and others. Data base products and services are described.

76 (EPRI-EA--922) STATE-OF-THE-ART WASTE HEAT UTILIZATION FOR AGRICULTURE AND AQUACULTURE. TECHNICAL PLANNING STUDIES 77-700 AND 77-734. FINAL REPORT. Hubert, W.A.; Madewell, C.E. (Tennessee Valley Authority, Chattanooga (USA)). Oct 1978. 360p. Dep. NTIS, PC A16/MF A01.

A state-of-the-art assessment of research, demonstration, and commercial projects that involve the use of power-plant-condenser cooling water for agricultural and aquacultural purposes was conducted. Information was obtained from published literature, site visits, and communications with knowledgeable individuals. Thermal-effluent uses are discussed for controlled-environment greenhouses, biological recycling of nutrients from livestock manures, soil heating and irrigation, environmental control for livestock housing, grain drying, and food processing, as well as the culture of numerous aquatic organisms. A large number of research and feasibility studies have been conducted, but few commercial enterprises are utilizing thermal effluent. Interfacing problems, environmental and legal restrictions, along with insufficient technology, have not allowed widespread commercial application. Specific research needs are discussed.

77 (EPRI-EA--1038) ECOSYSTEM EFFECTS OF PHYTOPLANKTON AND ZOOPLANKTON ENTRAINMENT. (Lawler, Matusky and Skelly, Pearl River, NY (USA)). Apr 1979. 226p. Dep. NTIS, PC A11/MF A01.

The literature on the effects of power plant entrainment on phytoplankton and zooplankton was reviewed to determine if a definitive documentation and assessment of the ecosystem effects of entrainment on these organism groups could be made. Few studies were found that attempted to address the ecosystem level directly, and many were designed only to meet

regulatory requirements for assessment studies. Many shortcomings were found in these studies. While these studies cannot be said to provide a definitive assessment at the ecosystem level, they do provide a large, consistent data base to document that the effects of entrainment on phytoplankton and zooplankton are generally small and unlikely to cause ecosystem-wide impacts. Except where the percentage of available water withdrawn for cooling is large or other evidence sugggests a unique situation, there is no need to conduct field studies on entrainment effects on a routine basis.

78 (EPRI-EA--1054(Vol.1)) SYNTHESIS AND ANALYSIS OF ECOLOGICAL INFORMATION FROM COOLING IMPOUNDMENTS. FINAL REPORT. Becker, C.D.; Cushing, C.E.; Gore, K.L.; Baker, K.S.; McKenzie, D.H. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Apr 1979. Contract EY-76-C-06-1830. 115p. Dep. NTIS, PC A06/MF A01.

The effects of a once-through cooling mode of power plant operation on small, essentially closed aquatic ecosysterns, represented by cooling impoundments were assessed. The primary objectives were: (1) to synthesize existing ecological data from cooling impoundments with a low load ratio; (2) to analyze these data to derive technically sound conclusions on plant operational impacts; (3) to identify what important effects cannot be assessed with existing data; and (4) to extrapolate the derived conclusions to other ecosystems. Fourteen cooling impoundments were selected and ecological information related to possible plant operational effects was collected and evaluated for these sites. The primary physical effect was the increment of surplus heat from plant condensers to the water body. Chemical changes were minimal, and were usually associated with long-term evaporation of water. Biological effects were largely qualitative, limited to a portion of the fish and plankton populations, and were not reflected at the community or ecosystem level. To the extent that no major ecosyster effects were identified in closed cocling impoundments, they would not be expected in open ecosystems.

79 (EPRI-EA--1054(Vol.2)) SYNTHESIS AND ANALYSIS OF ECOLOGICAL INFORMATION FROM COOLING IMPOUNDMENTS. VOLUME 2. APPENDIX A, STUDY SITE HISTORIES AND DATA SYNOPSIS. Becker, C.D.; Cushing, C.E.; Gore, K.L.; Baker, K.S.; McKenzie, D.H. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Apr 1979. Contract EY-76-C-06-1830. 291p. Dep. NTIS, PC A13/MF A01.

A literature review and assessment progam was undertaken to examine the effects of a once-through cooling mode of power plant operation on small, essentially closed aquatic ecosystems, represented by cooling impoundments. The primary objectives were to synthesize existing ecological data from cooling impoundments with a low load ratio (surface area in acres/plant capacity in MWe); to analyze these data to derive technically sound conclusions on plant operational impacts; to identify what important effects cannot be assessed with existing data; to extrapolate the derived conclusions to other ecosystems. Fourteen cooling impoundments were selected on the basis of physical criteria and availability of suitable references. Ecological information related to possible plant operational effects were collected and evaluated for these sites. The primary physical effect was the increment of surplus heat from plant condensers to the water body. Chemical changes were minimal, and were usually associated with long-term evaporation of water. Biological effects were largely qualitative, limited to a portion of the fish and plankton populations, and were not reflected at the community or ecosystem level. Most studies were not designed to quantify potential ecological impacts from power plant operation. Major data deficiencies restricting assessment of ecosystem effects were identified and discussed. To the extent that no major ecosystem effects were identified in ''closed'' cooling impoundments, they would not be expected in ''open'' ecosystems.

80 (EPRI-EA--1072) CHEMICAL EFFECTS OF POWER PLANT COOLING WATERS: AN ANNOTATED BIBLIOGRAPHY. Opresko, D.M.; Hannon, E.H. (Oak Ridge National Lab., TN (USA); Atomic Industrial Forum, Inc., Washington, DC (USA)). May 1979. 394p. Dep. NTIS, PC A17/MF A01.

Presented in the format of an annotated bibliography are 950 references dealing with the environmental impact of chemical discharges associated with power plant cooling systems. The references were extracted from the open literature for the period up to the fall of 1977 and from environmental reports and impact statements prepared for or by the electric utility industry. The topics covered pertain to currently used and potential biofouling control methods (chemical, thermal, mechanical); environmental effects of metals, corrosion inhibitors, and special use compounds released in cooling waters; and site-specific effects of chemical discharges on water quality and aquatic communities. The references are arranged by subject category, and indexes are provided to authors' names, keywords, scientific names of test organisms, geographic location of field research, and AIF accession numbers.

81 (EPRI-EA--1082) BIOFOULING CONTROL INVESTIGATIONS: 18-MONTH SUMMARY REPORT. Garey, J.F. (Marine Research, Inc., Falmouth, ME (USA)). May 1979. 101p. Dep. NTIS, PC A06/MF A01.

This study is a continuation of research which began in 1974 aimed at investigating alternatives to chlorination for controlling biofouling in power plants. The present study focused on the following areas of research which were shown by the original work to offer the greatest promise of success: continuous low-level chlorination; dechlorination; condenser antifouling treatment optimization; toxic coating; and freshwater ozonization.

82 (EPRI-ER--685(Vol.3)(App.)) REQUIREMENTS ASSESSMENT OF PHOTOVOLTAIC POWER PLANTS IN ELECTRIC UTILITY SYSTEMS. Marsh, W.D. (General Electric Co., Schenectady, NY (USA). Electric Utility Systems Engineering Dept.). Jun 1978. 123p. Dep. NTIS, PC A06/MF A01.

The following appendices are included: photovoltaic power plant technology, screening of photovoltaic candidate systems, loss-of-load probability method, utility system production costing, direct/diffuse insolation modeling, cost estimate of water cooling systems, air cooling methodology, and PV plant cost code of accounts. (MHR)

83 (EPRI-ER--1099) HEBER GEOTHERMAL DEMONSTRATION POWER PLANT. FINAL REPORT. (Fluor Engineers and Constructors, Inc., Irvine, CA (USA)). Jun 1979. 171p. Dep. NTIS, PC A08/MF A01.

The binary power plant is to be a 45 MW net electrical facility deriving energy from the low salinity (14,000 ppM), moderate temperature

(360°F, 182°C) Heber reservoir in Southern California. The optimized baseline design established for the power plant is described, and the design and optimization work that formed the basis for the baseline design is documented. The work accomplished during Phase II, Preliminary Design is also recorded, and a base provided from which detailed plant design could be continued. Related project activities in the areas of licensing, environmental, cost, and schedule are also described. The approach used to establish the Phase II optimized baseline design was to (1) review the EPRI Phase I conceptual design and feasibility studies; (2) identify current design criteria and state-of-the-art technology; and (3) develop a preliminary design optimized to the Heber site based on utility standards.

84 (EPRI-FP--953) EXAMINATION OF SPECIFIC ASPECTS OF COOLING TOWER TESTING METHODOLOGY. FINAL REPORT. Wilber, K.R. (Environmental Systems Corp., Knoxville, TN (USA)). Dec 1978. 113p. Dep. NTIS, PC A06/MF A01.

Closed cycle evaporative cooling systems are widely used presently and are being considered at many future sites for condenser cooling of steam electric power plants. Because these systems are intimately responsible for the efficiency of a power plant, it is important that they be properly specified, designed, constructed, and tested. Specific aspects of improved testing methodology including instrumentation and instrumentation deployment are discussed. Included is an investigation into the accuracy of instruments commonly used for determination of wet-bulb temperature. Additionally included is an examination of cooling tower capability calculations based on wet-bulb temperatures measured as the air enters the cooling tower versus at ground level upwind of the tower. The data show that calculations of capability may deviate from 0 to 10%, the differences being mainly attributed to consideration of recirculation of the exhausted cooling tower plume. To accommodate multiple-point inlet wet-bulb temperature measurements, a data acquisition system using platinum RTD's as sensing elements was employed. Despite some problems with the system electronics, it proved to be an efficient means of acquiring the data. Another area of examination dealt with water flow rate determinations using non-reinforced and reinforced pitot tubes. Among other things, it was concluded that accurate determination of the coefficient of the pitot tube is required, since standard coefficients supplied by the pitot tube manufacturer may be in error.

85 (EPRI-FP--1096) OPTIMIZATION-SIMULATION METHODOLOGY FOR WET/DRY COOLING. FINAL REPORT. Guyer, E.C.; Brownell, D.L.; Kach, R.A. (Dynatech R/D Co., Cambridge, MA (USA)). May 1979. 235p. Dep. NTIS, PC A11/MF A01.

The general problems of the optimum design and operation of wet/dry cooling systems for steam-electric plants are considered in relation to electric utility system generation expansion requirements and economic operation objectives. A methodology for the economic design and a strategy for the economic operation of a wet/dry system are developed which are based on the simulation of the operation of a wet/dry plant as a component of an integrated utility system. A computer program is formulated for the simulation of the optimum operation of a heat rejection system consisting of separate wet and dry tower modules in a series flow arrangement. This computer program is applied in the case study evaluation of the design and operation of wet/dry cooling systems for a typical large fossil-fired base-load plant. Two siting situations are considered: Boston, Massachusetts and Phoenix, Arizona.

86 (EPRI-RP--927-1) ECONOMICS OF CONSERVING WATER BY USE OF ALTERNATIVE COOLING METHODS FOR LARGE NUCLEAR, FOSSIL, AND COMBINED CYCLE POWER PLANTS. Rossie, J.P.; Mitchell, R.D.; Horsak, R.D.; Leidner, A.; Porter, R.M. (Beck (R.W.) and Associates, Denver, CO (USA)). Aug 1978. 92p. EPRI, Palo Alto, CA.

The development of future electric generating facilities in California is complicated by the fact that water resources generally are scarce, highly allocated, or influenced by regional institutional and legal considerations. Therefore, in order to determine the cooling system makeup water requirements for power plants and the changes in busbar energy production costs associated with the use of cooling methods which would reduce annual water requirements, computer analyses were performed for 1000-MWe nuclear, 1000-MWe fossil-fueled, and 400-MWe combined cycle power plants equipped with optimized wet, dry/wet peaking, and dry cooling tower systems for a range of site, design, and economic conditions.

87 (EPRI-WS--78-97, pp 124-126) GEYSERS ENVIRONMENTAL CONCERNS OR RISKS. Weinberg, C.J. (Pacific Gas and Electric Co., San Ramon, CA). Oct 1978.

From 2. geothermal conference; Taos, NM, USA (20 Jun 1978).

The vapor-dominated geothermal resource at The Geysers and the environmental concerns associated with the power plant are discussed. The following are included: analysis of geothermal steam and releases to the environment; hydrogen sulfide emissions abatement; air quality; cooling tower drift; stream and fish studies; vegetation mapping and wildlife studies; noise sources and levels; and geology, seismicity, and subsidence. (MHR)

88 (EPRI-WS--78-97, pp 53-56) WASTE HEAT REJECTION FROM GEOTHERMAL POWER PLANTS. Horsak, R.D.; Porter, R.M. (R.W. Beck and Associates, Denver, CO). Oct 1978.

From 2. geothermal conference; Taos, NM, USA (20 Jun 1978).

The objectives were (1) to identify the makeup water requirements for geothermal power production and (2) to develop analytical techniques and perform a comparative analysis of the waste heat rejection options for geothermal power plants to determine how water consumption may be reduced. The results will be used to identify options that are best suited for geothermal waste heat rejection by region, resource type, and conversion technology. Consideration is given only to high-temperature subsurface water reservoirs under pressure (commonly called hydrothermal resources) which offer potential for the development of commercial power generation facilities. Most of the known hydrothermal resources are located in the western United States, where water resources are scarce, highly allocated, or influenced by regional institutional and legal considerations. Wet, wet/dry, and dry cooling towers appear to be the principal cooling technologies for rejecting the waste heat from hydrothermal power plants. Comprehensive computer programs have been developed for this project for purposes of determining cooling water makeup requirements and energy production costs for the aforementioned cooling technologies. Parametric economic analyses have

been performed for both flash steam and binary conversion processes for various combinations of resource temperatures, climatological types, hydrothermal fuel costs, and cooling system makeup water costs.

89 (FE--2613-6(Vol.4E)) MHD-ETF PROGRAM FINAL REPORT, JANUARY 4, 1977--MARCH 4, 1978. VOLUME 4E. APPENDICES A26--A28. (General Electric Co., Philadelphia, PA (USA). Space Div.). Mar 1978. Contract EF-77-C-01-2613. 390p. Dep. NTIS, PC A17/MF A01.

A cooling tower trade-off study and NO/sub x/ kinetic analysis for the MHD Experimental Test Facility (ETF) are presented. An assessment of the ETF reliability, maintainability, and availability requirements is given. Studies include MHD-ETF failure rates and estimated maintenance elapsed time outages and manhours required per failure, fault trees for ETF combined cycle operation, and failure mode effect analysis. (WHK)

90 (FE--2635-T2) CONCEPTUAL DESIGNS FOR WATER TREATMENT IN DEMONSTRATION PLANTS. II. APPENDIX - DESIGN PROCEDURES. Seufert, F.B.; Hicks, R.E.; Wei, I.W.; Goldstein, D.J. (Water Purification Associates, Cambridge, MA (USA)). Mar 1979. Contract EF-77-C-01-2635. 215p. Dep. NTIS, PC A10/MF A01.

In making six conceptual water treatment designs, several design procedures are necessarily used several times. The design procedures used frequently are described in the following appendices. It is hoped that each appendix will enable an engineering reader to duplicate our design and to decide for himself whether our design equations are acceptable. A text book type of report is being written and will be issued by the US Environmental Protection Agency, Research Triangle Park, North Carolina, very soon (Contract 68-03-2207).

91 (GA-A--15340) FIXED MIRROR SOLAR CONCENTRATOR FOR APPLICATION TO A 100 MW(E) ELECTRIC GENERATING PLANT. Schuster, J.R. ; Neill, J.M.; Bass, J. (General Atomic Co., San Diego, CA (USA)). May 1979. Contract ET-78-C-03-2240. 6p. (CONF-790803--10). Dep. NTIS, PC A02/MF A01.

From 14. intersociety energy conversion conference; Boston, MA, USA (5 Aug 1979).

A design study was performed of a 100 MW(e) power plant that uses a Fixed Mirror Solar Concentrator (FMSC) to supply energy for steam generation. Various heat transport fluids were considered and draw salt was selected over Therminol 88 and sodium. The complete plant was modeled in a cost performance optimization code which automatically performed trade-offs such as reduced blocking vs increased piping costs, field piping heat loss vs pumping power, and fluid outlet temperature vs overall system efficiency. Various collector and receiver designs were studied and evaluated for their cost effectiveness. Operational requirements impacting the component designs were identified.

92 (HCP/M4131--01, pp 15-17) KAW VALLEY SOLAR BANK. Abbott, D. Nov 1978.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

The collector array consists of 72 General Electric TC-100 evacuated tube collectors. A 50/50 solution of water and glycol is circulated through the collector to a heat exchanger where energy is transferred via a water loop to the storage tank. During mild weather when the storage tank reaches its high limit the collector fluid is circulated through a heat dump where city water is boiled off dissipating excess heat. Energy is taken from the storage tank and circulated via a water loop to the heating coils or absorption chillers on demand. Heat is dissipated from the chillers through a cooling tower. A small chilled water storage tank is used to stop short cycling of the chillers. Domestic hot water is heated from a double walled heat exchanger in the solar loop. Backup energy is provided by a gas fired boiler.

93 (IAEA-R--1456-F) INVESTIGATIONS OF EFFECTS OF THERMAL DISCHARGES IN RHINE RIVER WATERS. PART OF A COORDINATED PROGRAMME ON THE PHYSICAL AND BIOLOGICAL EFFECTS OF COOLING SYSTEMS AND THERMAL DISCHARGES AT NUCLEAR POWER PLANTS. FINAL REPORT FOR THE PERIOD 1 JANUARY 1974 - 30 APRIL 1977. Schikarski, W. (International Atomic Energy Agency, Vienna (Austria)). Dec 1978. vpp. Dep. NTIS (US Sales Only), PC A02/MF A01.

The report envisages two aspects of cooling systems: heat exchange between water and atmosphere; cooling tower plume modeling. The author gives the estimated ''cooling capacity'' of German rivers and estuaries and describes a station at Rheinhausen, measuring directly the heat exchange between the river Rhine and the atmosphere. The influence of meteorological and topographical parameters is discussed, and the total uncertainty in extrapolating formulae is assessed. A number of field studies have been carried out to measure plume behavior of cooling towers and to provide the data basis for comparison of existing models. The average plume rise is well predicted. The experimental program carried out in Germany since 1973 is described. The one-dimensional models TOWER and SAUNA.S are in agreement with experimental results except for short plumes. The last plume model WALKURE shows considerable improvement. It is specially suited for the calculations of the cooling tower plume behavior under influence of temperature and humidity stratifications in the ambient atmosphere.

94 (IJS--106/5019-77) COOLING METHODS FOR POWER PLANTS. Gaspersic, B.; Fabjan, L.; Petelin, S. (Institut Jozef Stefan, Ljubljana (Yugoslavia)). 1977. 84p. (In Slovenian). Dep. NTIS (US Sales Only), PC A06/MF A01.

There are some results of measurements carried out on the wet cooling tower 275 MW(e) at TE Sostanj and on the experimental cooling tower at Jozef Stefan Institute, as well. They are including: the measurements of the output air conditions, the measurements of the cross current of water film and vapour-air flowing through two plates, and the distribution of velocity in boundary layer measured by anemometer.

95 (INIS-mf--4097) WASTE HEAT DISCHARGE FROM POWER PLANT COOLING TOWERS. A CONTRIBUTION TO THE DISCUSSION OF SITING PROBLEMS IN THE PLANNING OF POWER PLANTS AND POWER PLANT PARKS. (Ministerium fuer Arbeit, Gesundheit und Soziales des Landes Nordrhein-Westfalen, Duesseldorf (Germany, F.R.)). Mar 1977. 35p. (In German). NTIS, PC A03/MF A01.

Separate abstracts were prepared for individual papers presented in this report. (ERB)

96 (INIS-mf--4097, pp 9-14) THERMAL

POLLUTION OF THE ATMOSPHERE, IN PARTICULAR DUE TO POWER PLANT PARKS. Fortak, H. (Freie Univ. Berlin (Germany, F.R.)). Mar 1977. (In German).

Waste heat discharge from power plant cooling towers. A contribution to the discussion of siting problems in the planning of power plants and power plant parks.

A diagram is set up and described which relates the influence of power plant agglomerations on natural atmospheric phenomena, energetically and in some ways also dynamically. As there are no power plant agglomeration in existence at present, there is neither empirical knowledge on the meteorological and climatological effects to be expected from such agglomerations, nor are empirically proved theoretical predictions of the effects possible. In the diagram, the specific vertical energy flow is given for the thermal power emitted and the emission are for natural and anthropogenic thermal sources, and characteristic values are calculated for the thermal lift and the vertical velocity at representative heights above the area. As far as the arrangement of cooling towers is concerned, it is found that it is better to avoid cooling tower agglomerations on small areas and to erect smaller power stations distributed over a large area instead.

97 (INIS-mf--4316, pp 15-23) SPECIFIC FEATURES OF USING VARIOUS TYPES OF COOLERS IN NPP WITH THE N_2O_4 COOLANT. Peslyak, V.I.; Sobolevskij, R.G. (AN Belorusskoj SSR, Minsk. Inst. Yadernoj Ehnergetiki). 1977. (In Russian).

Dissociating gases as coolants and working fluids in power plants. III.

Technical characteristics and economic parameters of process water power supply systems with "dry" cooling towers have been analysed for a 1000 MW nuclear power plant (NPP) with a fast nitrogen tetroxide-cooled reactor. Process water supply systems for the NPP of the type are compared to those for NPP with WWER type reactors and thermal power plants.

98 (K/CSD/INF--79/6) COOLING TOWER RECIRCULATION AS INFLUENCED BY THE LOCAL ATMOSPHERIC FLOW FIELD, A NUMERICAL MODEL. Becker, B.R.; Frost, W. (Union Carbide Corp., Oak Ridge, TN (USA). Nuclear Div.). 1979. Contract W-7405-ENG-26. 35p. (CONF-791205--1). Dep. NTIS, PC A04/MF A01.

From ASME winter annual meeting; New York, NY, USA (2 Dec 1979).

Cooling tower performance is adversely affected by the recirculation of stack effluent back into the tower intake louvers. A unique method of numerically modeling cooling tower plume recirculation is described. The structure of the wake region behind the tower is resolved using the equations of hydrodynamics. The flow field within the tower is modeled as porous media flow. Interior and exterior flow fields are coupled by matching pressures and flow rates at the intake louvers.

99 (K/GD--1917) COOLING TOWER DRIFT STUDY AT OAK RIDGE GASEOUS DIFFUSION PLANT. Park, S.H.; Vance, J.M. (Oak Ridge Gaseous Diffusion Plant, TN (USA)). May 1978. Contract W-7405-ENG-26. 27p. (CONF-780533--2). Dep. NTIS, PC A03/MF A01.

From Symposium on cooling tower environment; College Park, MD, USA (2 May 1978).

New drift studies on the mechanical draft cooling towers at the Oak Ridge Gaseous Diffusion Plant are being planned to provide data necessary for the building and evaluation of a practical analytical model that will describe drift transport and deposition for existing and new towers. A previous study in 1973 provided the groundwork, but needs to be extended to characterize the effect on drift mechanisms of variations in meteorological and operating conditions, as well as the influence imposed by tower condition, tower type, and terrain. Some inconsistencies in source measurements in the 1973 study also need to be resolved, since errors in this input measurement to existing models are magnified by a factor of seven in the deposition results. It is contended that large droplets (>900 μm) constitute a significant fraction of the total drift and must be accounted for in future measurements. Based on the results of the previous study, a new test plan and measuring method have been formulated and are outlined. It is believed that the extensive measurements of the new study will provide reliable data in quantity for a better statistical analysis that will enhance the formulation of a credible drift model.

100 (K/GD--1967) SINGLE-CELL COOLING TOWER PERFORMANCE STUDIES. PART I: THE EFFECT OF REDUCED TIP CLEARANCE ON FAN PERFORMANCE. PART II: THE EFFECT OF REDUCED TIP CLEARANCE ON COOLING TOWER PERFORMANCE. Brock, W.R.; Woodard, J.S. (Oak Ridge Gaseous Diffusion Plant, TN (USA)). 1979. Contract W-7405-ENG-26. 56p. (CONF-790109--2). Dep. NTIS, PC A04/MF A01.

From Cooling tower institute annual meeting; Houston, TX, USA (22 Jan 1979).

Union Carbide Corporation-Nuclear Division at the Oak Ridge Gaseous Diffusion Plant has been involved in cooling tower testing for some time. Most recent efforts have been directed toward evaluating the effects of reduced blade tip clearance on fan and tower performance. The paper consolidates these efforts which were originally documented in two separate reports. Data and results are presented which show that large improvements in fan efficiency (static and total), significant monetary savings, and substantial increase in tower performance can result from reducing the fan blade tip clearance on cooling towers.

101 (N--78-14764) PHYSICAL PARAMETERS IN CONNECTION WITH THE COOLING TOWER MEASUREMENT CAMPAIGNS. Boegel, W. (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt e.V., Oberpfaffenhofen (Germany, F.R.). Inst. fuer Physik der Atmosphaere). 17 Dec 1975. 29p. (DLR-IB--553-75/15). NTIS PC A03/MF A01.

The nomenclature, used in a cooling tower measurement campaign, was adapted to the terminology used in a VDI (Association of German Engineers) publication on a similar project, taking due account of existing norms. The meteorological and other interesting parameters of the VDI publication were tabularized together with the German, international, and WMO norms. In a second table, the WMO norms on air humidity parameters are presented.

102 (NP--23707) STANDARDIZED CALCULATION OF COOLING TOWERS. Harting, P.E. (Technische Univ. Braunschweig (Germany, F.R.). Fakultaet fuer Maschinenbau und Elektrotechnik). 1 Jul 1977. 114p. (In German). Dep. NTIS (US Sales Only), PC A06/MF A01.

Thesis.

For a standardized calculation and assessment of the basic cooling tower types,

methods are given for calculating the evaporation characteristics as a characteristic cooling tower value for counterflow and crossflow systems. For the crossflow cooling tower, an optimization method is given which will permit statements on the changes in the geometry of cooling tower intervals. Finally, a method is presented for calculating the evaporation characteristics and the off-air for natural-draft cooling towers; both of these figures are strongly dependent on wind velocity and on the climatic seasonal conditions.

103 (NP--23880) STUDY OF THE INFLUENCE OF COOLING WATER ADDITIVES ON SURFACE WATERS. Wunderlich, M. (Bundesanstalt fuer Gewaesserkunde, Koblenz (Germany, F.R.)). Feb 1978. 61p. (In German). Dep. NTIS (US Sales Only), PC A04/MF A01.

The study is intended to give a survey of the present state of the applications of chemicals in cooling processes. The influence of these agents on surface waters increases with the increasing use of circulation cooling. Basis of the study is a literature survey and an elaboration by two professional organizations, which had been suggested by the Federal Institute of Hydrology. On this basis, model computations were carried out in the form of limiting-value determinations for a single power station with circulation cooling, involving the most important cooling water treatment agents. The study shows that at present and in the foreseeable future, cooling water agents are not of global significance. Regionally, however, low discharge streams may be influenced by the chemical additives. Recommendations to producers, distributors and users of cooling water chemicals are given. Questions still open are indicated.

104 (NTIS/PS--78/0898) COOLING TOWERS (CITATIONS FROM THE NTIS DATA BASE). REPORT FOR 1964-AUGUST 1978. Hundemann, A.S. (National Technical Information Service, Springfield, VA (USA)). Aug 1978. 277p.

Abstracts of Federally-funded research dealing with design and environmental impacts of wet and dry cooling towers are presented. Cooling tower drift instrumentation and thermal and chemical pollution control systems are covered. Citations primarily pertain to cooling towers used in nuclear power plants, with a few pertaining to cooling towers used in wastewater treatment. (This updated bibliography contains 271 abstracts, 51 of which are new entries to the previous edition.)

105 (NTIS/PS--78/0895) COOLING TOWERS: DESIGN AND PERFORMANCE (CITATIONS FROM THE ENGINEERING INDEX DATA BASE). REPORT FOR 1970-AUGUST 1978. Hundemann, A.S. (National Technical Information Service, Springfield, VA (USA)). Aug 1978. 312p.

Abstracts from worldwide research on design and performance of mechanical draft and natural draft wet, dry, and dry-wet combination cooling towers are discussed. Citations cover studies on size reduction, corrosion protection, and economic optimization of cooling towers primarily used with nuclear power plants and fossil fuel power plants. A few abstracts pertain to cooling towers used in wastewater treatment. (This updated bibliography contains 305 abstracts, 65 of which are new entries to the previous edition.)

106 (NTIS/PS--78/0900) COOLING TOWERS: ENVIRONMENTAL STUDIES (CITATIONS FROM THE ENGINEERING INDEX DATA BASE). REPORT FOR 1970-AUGUST 1978. Hundemann, A.S. (National Technical Information Service, Springfield, VA (USA)). Aug 1978. 144p.

Abstracts from worldwide research on thermal, meteorological, and ecological effects associated with cooling towers used primarily by fossil fuel and nuclear power plants are cited. Citations cover plume behavior studies, including measurement of airborne particulate concentration, and characterization and management of drift as well as noise pollution and salt deposition effects on vegetation. A few abstracts pertain to environmental effects from cooling towers used in wastewater treatment. (This updated bibliography contains 138 abstracts, 21 of which are new entries to the previous edition.)

107 (NUREG--0247) COOLING SYSTEMS ADDENDUM: CAPITAL AND TOTAL GENERATING COST STUDIES. (United Engineers and Constructors, Inc., Philadelphia, PA (USA)). Mar 1978. Contract EY-76-C-02-2477. 161p. (COO--2477-15). Dep. NTIS, PC A08/MF A01.

These studies present the capital and total generating costs for alternate cooling systems designed for six power plants--1200 MWe (pressurized water reactor, boiling water reactor, high sulfur coal-fired, low sulfur coal-fired) plants and 800 MWe (low-sulfur coal-fired and high-sulfur coal-fired) plants. In these base-capital cost studies, all of the plants are designed using mechanical-draft evaporate towers. Alternate cooling systems evaluated include: once-through, fan-assisted natural-draft towers, and natural-draft towers. These alternative cooling systems represent viable designs from both an economic and engineering standpoint. The estimated total base construction costs for the six plants incorporating the alternate cooling systems are summarized. Capital cost and fuel cost vary with each cooling system as compared to the base case; i.e., mechanical-draft evaporative towers. The once-through cooling systems have the lowest capital cost of the alternate systems evaluated.

108 (NUREG/CP--0002, pp 15-25) COOLING WATER INTAKES UTILIZING RANNEY COLLECTORS OR RANNEY INTAKES. Mikels, F.C. (Ranney Method Western Corp., Kennewick, WA); Bennett, T.W. Aug 1978.

From Workshop on larval exclusion systems for power plant cooling water intakes; San Diego, CA, USA (7 Feb 1978).

Minimization of the loss of aquatic biota is a major factor in the location, design, construction, and capacity of cooling water intake structures. In a comprehensive report, the U.S. Environmental Protection Agency (1976) has reviewed the present methods and technology available for minimizing adverse environmental impact of cooling water intakes. Two types of intakes, described in the report and classified as non-conventional intakes, are discussed in this paper: the Ranney Collector, which is a subsurface intake utilizing natural sand and gravel deposits to transmit water from a surface source, and the Ranney Surface Water Intake, which is a submerged, horizontal perforated-pipe intake.

109 (NUREG/CP--0002, pp 5-12) ENGINEERING CONSIDERATIONS IN THE USE OF ARTIFICIAL FILTER BEDS. Richards, R.T. (Burns and Roe, Inc., Paramus, NJ). Aug 1978.

From Workshop on larval exclusion systems for power plant cooling water intakes; San Diego, CA, USA (7 Feb 1978).

Artificial filter bed intakes utilize a

prepared granular filter material to prevent entrance of debris and aquatic life into a water withdrawal facility. The relatively large quantities of water and the service reliability required for power plant cooling water systems present major engineering problems for the artificial filter concept, many of which have not been resolved. These problems include development of a suitable and stable filter medium; design of a reliable backwash system which is both effective and environmentally acceptable; meeting of all site-imposed restrictions relating to natural river turbidity, flooding characteristics, channel stability, and ice loads; and provision of the complex civil and mechanical engineering design inherent in such a system. Extensive model testing may be required for further engineering development of this system. The preliminary engineering for an artificial filter system is discussed in connection with a proposed 1.6-m^3/s-capacity (25,000-gpm capacity) filter in the Columbia River.

110 (NUREG/CP--0002, pp 37-50) ENGINEERING EVALUATION OF POROUS-DIKE INTAKE SCREENING SYSTEMS. Roberge, J.C. (Alden Research Lab., Holden, MA). Aug 1978.

From Workshop on larval exclusion systems for power plant cooling water intakes; San Diego, CA, USA (7 Feb 1978).

As one of many concepts currently under investigation for use in screening fish and larvae from power plant intakes, the porous-dike system presents unique challenges to the designer and constructor. A complete understanding of the hydraulic losses through such a structure is necessary to properly size and locate the intake and to ensure proper pump selection and performance. In the study described in this report, an analogy with frictional losses in conduits was employed, and empirical data on losses were determined for three sizes of filter stone typical of the types used in the construction of a porous-dike intake system. These empirical data were compared with additional information from the literature. The dependence of hydraulic losses through large-diameter media on stone shape and porosity were demonstrated although no empirical expression of this dependence was developed. A hypothetical porous-dike intake installation was developed, demonstrating the fundamental design considerations which must be made for such a structure. Finally, a cursory economic comparison of various intake screening systems demonstrated that the porous-dike intake concept was economically competitive with all others.

111 (NUREG/CP--0002, pp 51-63) BIOLOGICAL ASPECTS OF POROUS-DIKE INTAKE STRUCTURES. Schrader, B.P.; Ketschke, B.A. (New England Power Service Co., Westborough, MA). Aug 1978.

From Workshop on larval exclusion systems for power plant cooling water intakes; San Diego, CA, USA (7 Feb 1978).

Current knowledge is reviewed on the potential for both adult and larval exclusion with a porous dike. It is shown that exclusion is possible, given small enough filter material. In addition, limited observations show that some adult and larval fish will avoid a porous-dike intake, thereby suggesting that dikes can also act as behavioral barriers. Information on fouling and clogging of porous dikes is reviewed, and proposed anti-fouling techniques are discussed. Data are too limited for prediction of flow restrictions due to fouling; however, it is shown that fouling is not a problem when large filter material is used in the dike. To determine the feasibility of a porous-dike intake, a pilot-scale field experiment is proposed. The proposed in-situ test facility, to be installed in Mount Hope Bay, Mass., is described. Plans to assess the exclusion capability and fouling rates of several dike materials are presented. A parallel laboratory program of larval behavioral studies is described. Results of this study are expected in 1981.

112 (NUREG/CP--0002, pp 79-87) SURVIVAL OF DOMINANT ESTUARINE ORGANISMS IMPINGED ON FINE-MESH TRAVELING SCREENS AT THE BARNEY M. DAVIS POWER STATION. Murray, L.S.; Jinnette, T.S. (Central Power and Light Co., Corpus Christi, TX). Aug 1978.

From Workshop on larval exclusion systems for power plant cooling water intakes; San Diego, CA, USA (7 Feb 1978).

One of the primary environmental impacts associated with electric generating stations in the United States is the loss of aquatic organisms passing through, or impinged on, various screening media at intake structures. Historically, many traveling screens have been fitted with 3/8-inch mesh and designed primarily to screen out aquatic organisms and debris to prevent clogging of pumps and condenser tubes. Presently, comparatively new screening technologies are being evaluated by the power industry in an effort to alleviate impingement losses at power plant intakes. An impingement study was conducted at the Barney M. Davis Power Station, Corpus Christi, Texas. The study spanned twelve months, beginning in January 1977, and ending in December 1977. The primary purpose of this study was to accurately describe survival of marine organisms, principally dominant fishes and shrimps, impinged on Passavant fine-mesh center-flow traveling screens. The influence of debris loading on the survival of selected dominant species also was examined.

113 (NUREG/CP--0002, pp 91-105) CURRENT TVA WORK ON THE FLUID MECHANICS OF SCREENS WITH VERY SMALL OPENINGS FOR THE EXCLUSION OF LARVAE AT POWER PLANT COOLING-WATER INTAKES. Vigander, S. (Tennessee Valley Authority, Norris). Aug 1978.

From Workshop on larval exclusion systems for power plant cooling water intakes; San Diego, CA, USA (7 Feb 1978).

The potential use of screening media with very small openings to exclude larval fish at power plant cooling-water intakes opens several areas of possible fluid mechanic problems. In this paper, ongoing research is described which focuses on four specific areas: the prediction of the pressure drop across a screen, given flow rate and screen properties; the estimation of the pressure drop across partially plugged screens; the rate of debris buildup on a site-specific stationary screen sample; and methods for stationary screen cleaning and their effectiveness. Other areas are identified in which research is needed to aid in the design of intakes that will effectively exclude larvae.

114 (NUREG/CP--0002, pp 107-123) BIOLOGICAL AND ENGINEERING CONSIDERATIONS IN THE FINE-SCREENING OF SMALL ORGANISMS FROM COOLING WATER INTAKES. Mussalli, Y.G.; Taft, E.P.; Hofmann, P. (Stone and Webster Engineering Corp., Boston, MA). Aug 1978.

From Workshop on larval exclusion systems for power plant cooling water intakes; San Diego, CA, USA (7 Feb 1978).

Fine-screening of small organisms can be

grouped into two concepts: impingement and deterrent. Impingement concepts involve the collection and removal of organisms with through-flow, center-flow, and dual-flow traveling screens. In evaluating the biological effectiveness of these screens, consideration should be given to species, approach and through-mesh velocities, mesh opening, impingement duration, debris loading, and type of organism wash system. Engineering considerations include potential for clogging, need for continuous operation of the screen, and screening material. Furthermore, each type of traveling screen has advantages and disadvantages relating to the potential for debris and organism carryover, screening area, screenwell layout, velocity distribution along screen face, and potential effect on pump performance. Impingement and diversion systems require that collected organisms be returned to the source water body. Transport systems can utilize either gravity flow or pumping units. The impingement concept appears to be the most practicable solution for once-through cooling systems. Deterrent concepts, in which the organisms passively drift by a screening device, include infiltration systems such as radial wells, porous dikes, and wedge-wire screens. Biologically, the radial wells and wedge-wire screens will cause little impact to small organisms. The porous dike has not been employed for the protection of small organisms to date. Engineering considerations presently limit the use of wedge-wire screens and radial wells to makeup water intakes with small withdrawals.

115 (NUREG/CP--0002, pp 125-139) INVESTIGATIONS ON THE PROTECTION OF FISH LARVAE AT WATER INTAKES USING FINE-MESH SCREENING. Tomljanovich, D.A.; Heuer, J.H.; Voigtlander, C.W. (Tennessee Valley Authority, Norris). Aug 1978.

From Workshop on larval exclusion systems for power plant cooling water intakes; San Diego, CA, USA (7 Feb 1978).

A laboratory study was conducted to evaluate the potential use of fine-mesh screens for protecting larval fish exposed to water intakes. The study was designed to determine the relationships of percentage retention (impingement) and post-impingement survival of larvae to fish species and size, approach water velocity, test duration (impingement duration), and size of screen openings. The larval fish species tested showed a wide range in body shapes; for the screens with openings larger than 0.5 mm, percentage retention was directly related to body depth. Of five screen opening sizes used in the experiment only the 0.5-mm opening retained essentially 100% of the smallest larvae. Screens of openings 1.0 mm or larger retained only a small percentage of the smallest larvae. Velocity and test duration contributed little to the percentage retention. Post-impingement survival of larval fish in the laboratory was shown to be inversely related to duration of impingement and dependent on species and size and, to a lesser extent, current velocity.

116 (NUREG/CP--0002, pp 141-147) ENGINEERING AND HYDRAULICS OF THE MODIFIED PERFORATED-PIPE INTAKE. Richards, R.T. (Burns and Roe, Inc., Paramus, NJ). Aug 1978.

From Workshop on larval exclusion systems for power plant cooling water intakes; San Diego, CA, USA (7 Feb 1978).

The perforated pipe is a simple screening device which has many advantages in the reduction of both impingement and entrainment under certain water source conditions. The basic perforated pipe has been successfully used for many years. The modified perforated pipe (modified to give uniform inflow velocities) is a relatively new concept and is discussed in detail. A third approach being developed to reduce entrainment is the perforated or wedge-wire pipe with very small openings. For perforated-pipe intakes in general there are many areas remaining to be researched, including perforation type and size, orientation and shape of screens, fouling characteristics, and water and air backwash facilities.

117 (NUREG/CP--0002, pp 149-157) JOHNSON SCREEN FOR COOLING WATER INTAKES. Cook, L.E. (Johnson Division, UOP Inc., St. Paul, MI). Aug 1978.

From Workshop on larval exclusion systems for power plant cooling water intakes; San Diego, CA, USA (7 Feb 1978).

Johnson surface-water screens provide an alternative to vertical traveling screens for power plant cooling water intakes. In this paper, flow field modeling is discussed, and a series of case studies is presented. The hydraulic information obtained is discussed as it applies to the exclusion of biota and debris from cooling water intake systems.

118 (NUREG/CP--0002, pp 159-167) IN-SITU TESTING OF PROFILE WIRE SCREENS FOR LONG-TERM ENGINEERING FEASIBILITY. Miller, J.C. (Delmarva Power and Light Co., Wilmington, DE); Charles, K.E.; Key, T.H. Aug 1978.

From Workshop on larval exclusion systems for power plant cooling water intakes; San Diego, CA, USA (7 Feb 1978).

A facility for testing profile-wire screens in a brackish-water environment was installed in the Chesapeake and Delaware Canal. The primary objective of this test program was to demonstrate reliable, long-term operation of profile-wire screens with a slot opening of 1 mm (0.040 in.). A cylindrical screen 0.76 m (30 in.) in diameter and 0.56 m (22 in.) long having an open area of approximately 20% of the surface was tested for nine months. Water was drawn through the screen at an average velocity of 0.1 m/s (0.5 fps) for a design flow of 0.042 m^3/s (660 gpm). The screen operated in excess of two months before the system shut down due to clogging. Backwashing with high-volume, low-pressure water returned the system to normal operating conditions. Continued fouling by marine growth and silt required removal of the screen for cleaning approximately every three weeks. The screen was successfully cleaned in 15 to 20 min using a low-volume (1.2×10^{-4} m^3/s [2 gpm]), high-pressure (3.45 MPa [500 psi]) water spray. The test facility was removed from the canal in late December 1977, to prevent damage from ice. Testing has indicated that small-slot profile-wire screens have potential for power station usage. The major problem was clogging of the screens by marine growth during summer and early fall. Any proposed usage of small-slot profile-wire screens should be preceded by a comprehensive in-situ test program to determine the operating and maintenance requirements necessary to ensure long-term reliability.

119 (NUREG/CP--0002, pp 195-233) PRACTICALITY OF PROFILE-WIRE SCREEN IN REDUCING ENTRAINMENT AND IMPINGEMENT. Hanson, B.N.; Bason, W.H.; Beitz, B.E.; Charles, K.E. (Ichthyological Associates, Inc., Middletown, DE). Aug 1978.

From Workshop on larval exclusion systems for power plant cooling water intakes; San

Diego, CA, USA (7 Feb 1978).
Experimental studies indicated that 1.01-mm slot profile-wire well screen operated at an intake velocity of 15.24 cm/s virtually eliminated impingement of fishes larger than 15 mm fork length (FL). Intake velocities as high as 53.34 cm/s produced low impingement. Tests of fish less than 40 mm FL held near a functioning intake (15.24 cm/s) for as long as 3 hr yielded no impingement or stress. Many striped bass between 8 and 17 mm FL were capable of resisting impingement at more than 30.48 cm/s velocity for longer than 30 min; larger specimens (12 to 17 mm) showed excellent ability to escape when impinged. The screen excluded virtually all striped bass eggs from the cooling water. Preliminary egg mortality studies indicate that at least 95% survival can be expected at an approach velocity of 15.24 cm/s and impingement durations up to 2 min. Fouling studies showed that screens were highly resistant to clogging, essentially self-cleaning in a current, and easily backwashed. In-situ studies in the Chesapeake and Delaware Canal have shown that a 61.0- x 76.2-cm, 1.01-mm-slot screen is capable of providing its designed capacity for weeks without backwashing or cleaning. Biofouling proved to be the greatest operational problem. Entrainment samples from the in-situ intake have shown significant reductions in organisms/m^3 of filtered versus ambient water.

120 (NUREG/CP--0002, pp 169-194) STUDY ON THE PROTECTION OF FISH LARVAE AT WATER INTAKES USING WEDGE-WIRE SCREENING. Heuer, J.H.; Tomljanovich, D.A. (Tennessee Valley Authority, Norris). Aug 1978.
From Workshop on larval exclusion systems for power plant cooling water intakes; San Diego, CA, USA (7 Feb 1978).
The Tennessee Valley Authority has conducted a laboratory study designed to evaluate the ability of several species of larval fish to avoid entrainment through and impingement against wedge-wire stationary screen (fish avoidance concept). The results are presented in this study. The fish avoidance concept features small-opening screens, low inlet velocities, and an unobstructed bypass. Its success is dependent on the ability of larvae to detect and swim away from the screens. The study was designed to test this concept in a flowing-water environment. All species showed some ability to avoid entrainment, and many species showed considerable avoidance of entraining flows. Safe bypass or avoidance of entrainment was generally related inversely to slot size and slot velocity. Best results were shown for the 0.5-mm slot and 7.6 cm/s (0.25 fps) slot velocity. At least one of the smallest species showed appreciable avoidance of the largest slot size (2.0 mm) tested. From a biological point of view this screening concept has the potential for protecting nearly all fish of impingeable size as well as a large portion of fish of entrainable size.

121 (NUREG/CP--0002) LARVAL EXCLUSION SYSTEMS FOR POWER PLANT COOLING WATER INTAKES. Sharma, R.K.; Palmer, J.B. (eds.). (Argonne National Lab., IL (USA)). Aug 1978. Contract W-31-109-ENG-38. 243p. (ANL/ES--66; CONF-780257--). Dep. NTIS, PC A11/MF A01.
From Workshop on larval exclusion systems for power plant cooling water intakes; San Diego, CA, USA (7 Feb 1978).
Separate abstracts were prepared for 16 of the 19 papers presented in these proceedings. Two of the three remaining papers are presented in summary form only. They discuss high-capacity filters for power plant cooling water intakes and larval exclusion with woven-slot, fine-mesh screening. The third paper for which an abstract was not prepared is a review paper presenting a synthesis of views presented at the workshop. (ERB)

122 (NUREG/CP--0002, pp 27-36) HYDROLOGIC ENGINEERING CONSIDERATIONS FOR RANNEY COLLECTOR WELL INTAKE SYSTEMS. Beskid, N.J. (Argonne National Lab., IL). Aug 1978.
From Workshop on larval exclusion systems for power plant cooling water intakes; San Diego, CA, USA (7 Feb 1978).
The basic hydrologic aspects affecting the location, design, and operation of Ranney Collector Well intake structures are presented. Siting and design considerations are discussed and the types of problems that require site-specific design considerations are outlined. The fundamental concepts of hydrology related to collector well design, such as surface water flow regime and the more complex groundwater hydraulics, are briefly discussed. Emphasis is placed on the application of the results of field pumping tests to the estimation of aquifer properties, groundwater flow, and infiltration rates and the utilization of these parameters as input to Ranney Collector Well system design.

123 (NUREG/CP--0002, pp 65-68) ENGINEERING ASPECTS OF PASSAVANT SCREENING. Siddle, K.R. (Passavant Corp., Birmingham, AL); Sharma, R.K. Aug 1978.
From Workshop on larval exclusion systems for power plant cooling water intakes; San Diego, CA, USA (7 Feb 1978).
The Passavant screen was developed in Europe almost 30 years ago. The Passavant screen is a vertical traveling screen; however, the basic difference between the conventional vertical traveling screen and the Passavant screen is that in the conventional screen water passes through the front screen belt and then the back screen belt, whereas in the Passavant screen the water enters in between the two belts and passes laterally through either of the belts. Thus, theoretically, the screening surface of the Passavant screen is doubled as compared to the same size conventional vertical traveling screen. Various design and operational modifications of the Passavant screen are possible to yield optimum design and performance characteristics which make it amenable to installation at power plants for safe removal of not only fish but also smaller organisms such as fish eggs and larvae. In this paper, details of the screen design and operational characteristics are discussed with notes on how these features can be modified to suit site- and organism-specific requirements.

124 (NUREG/CP--0002, pp 69-77) INVESTIGATIONS ON THE PROTECTION OF FISH LARVAE AT WATER INTAKES USING FINE-MESH SCREENING IMPINGEMENT-RELEASE CONCEPT: LABORATORY STUDY OF A SINGLE-ENTRANCE, DOUBLE-EXIT, VERTICAL TRAVELING SCREEN CONCEPT. Magliente, S.H. (Tennessee Valley Authority, Chattanooga); Tomljanovich, D.A.; Heuer, J.H.; Vigander, S.; Smith, M.N. Aug 1978.
From Workshop on larval exclusion systems for power plant cooling water intakes; San Diego, CA, USA (7 Feb 1978).
The Tennessee Valley Authority (TVA) is investigating the concept of protecting larval fish at power plant intakes using fine-mesh screening. The larvae can be safely impinged on the screens, washed off the screens, and returned to the source water body (impinge-release concept). Initial studies by TVA have

indicated that such a concept of screening larval fish is feasible. A single-entry, double-exit vertical traveling screen was selected for the experimental test facility. Such a screen has desirable characteristics for safe handling of fish and is amenable to design modifications if warranted. Testing is designed to evaluate larval fish survival using the impinge-release concept for commercially available modified and unmodified screens. The importance of various stresses critical to survival of larvae will be examined under laboratory conditions.

125 (NUREG/CR--0341) REACTOR SAFETY RESEARCH PROGRAMS. QUARTERLY REPORT, APRIL 1--JUNE 30, 1978. Hooper, J.L. (ed.). (Battelle Pacific Northwest Labs., Richland, WA (USA)). Sep 1978. Contract EY-76-C-06-1830. 158p. (PNL--2653-2). Dep. NTIS, PC A08/MF A01.

Progress is summarized in the following LWR safety-related studies: ultimate heat sink performance measurements; steam generator tube integrity; acoustic emission; irradiation results of experimental verification of steady state codes; ex-reactor verification of steady state codes; determination of thermal gap and contact conductance; code development; fuel subassembly procurement and irradiation test progras; LOCA simulation in NRU; and core thermal model development; non-destructive testing for oxidation of graphite samples is described.

126 (NUREG/CR--0456) RANCHO SECO BUILDING WAKE EFFECTS ON ATMOSPHERIC DIFFUSION. Start, G.E.; Cate, J.H.; Dickson, C.R.; Ricks, N.R.; Ackerman, G.R.; Sagendorf, J.F. (National Oceanic and Atmospheric Administration, Idaho Falls, ID (USA). Environmental Research Labs.). Nov 1977. 186p. NTIS, PC A09/MF A01.

A series of 23 paired gaseous tracer releases at the Rancho Seco Nuclear Power Station in 1975 was the third of several tests designed to investigate the diffusion characteristics of the atmosphere under conditions of low windspeed and temperature inversion. This test also evaluated the effects of flow around buildings upon dilution of pollutants. Gaseous tracers were laterally dispersed about six times more than the expected amounts from Pasquill--Gifford curves of sigma-y. Most of this increase could be related to observed variance of the horizontal wind direction (meandering). For ground-level releases the effective sigma-z values were 16 times greater than the corresponding values from the Pasquill--Gifford curves. Measured ground-level axial concentrations were about 75 times smaller than predicted by the Gaussian diffusion equation for a ground-level release when Pasquill--Gifford values of sigma-y and sigma-z were used.

127 (NUREG/CR--0504) BIOCIDE BY-PRODUCTS IN AQUATIC ENVIRONMENTS. ANNUAL REPORT, OCTOBER 1, 1977--SEPTEMBER 30, 1978. Anderson, D.R.; Bean, R.M.; Gibson, C.I. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Jan 1979. Contract EY-76-C-06-1830. 67p. (PNL--2806). Dep. NTIS, PC A04/MF A01.

The Biocide By-Products in Aquatic Environments Program is composed of analytical chemistry and biological phases with freshwater and marine biological subdivisions. The objectives of the analytical studies are: to identify those chloroorganic chemical compounds that result from the addition of chlorine to fresh or saltwater; to develop methods for detecting chlorinated organics in the effluents discharged tc receiving water bodies from nuclear stations; and to verify laboratory findings through analysis for chlorination by-products in water and biota samples from cooling water bodies of nuclear power stations. The objectives of the biological studies are: to investigate the immediate toxicity of specific chlorination by-products (chloroform in freshwater and bromoform in marine waters); to evaluate the chronic toxicity of chlorination by-products; to follow their pathways of action; and to analyze for bioaccumulation or biomagnification of halogenated hydrocarbons on selected aquatic or marine biota.

128 (NUREG/CR--0514) ENVIRONMENTAL ASSESSMENT OF COOLING RESERVOIRS. Parkhurst, B.R.; McLain, H.A. (Oak Ridge National Lab., TN (USA)). Oct 1978. Contract W-7405-ENG-26. 90p. (ORNL/NUREG/TM--226). Dep. NTIS, PC A05/MF A01.

The environmental impacts, both adverse and beneficial, of cooling reservoirs are compared to cooling towers as an alternative closed cycle cooling system. Generally, the impacts associated with the construction of a cooling reservoir system are greater than for a comparable cooling tower system. Operational impacts are generally greater for cooling towers due to their visual impact, plus icing, fogging, and noise problems. The principle advantages of cooling reservoirs are their lower operating and maintenance costs, greater reliability, greater cooling efficiency, reduced water consumption in areas where cooling water storage is required, and their multiple use potential. A review of pertinent literature on cooling reservoir ecosystems, has revealed that entrainment, thermal, and chemical effects generally result in reduced populations of phytoplankton, zooplankton, and benthos in the vicinity of the power plant discharge. Adverse far field effects are generally less significant and are sometimes stimulatory. The overall effects of a power plant on the fish populations of cooling reservoirs appear to be minor. Based on the thermal characteristics of a model 6400 acre cooling reservoir with four 1150 MWe reactors, the ecological characteristics of the reservoir were predicted. The multiple use possibilities of cooling reservoirs provide their most significant beneficial aspect when compared to cooling towers. In addition, the cage culture of food fishes in cooling reservoirs provides an economical and practical method of commercially utilizing the waste heat discharged by power plants. For many areas of the country, cooling reservoirs appear to provide an environmentally and socially desirable alternative to cooling towers.

129 (NUREG/CR--0546) REACTOR SAFETY RESEARCH PROGRAMS. QUARTERLY REPORT, JULY 1--SEPTEMBER 30, 1978. Hooper, J.L. (comp.). (Battelle Pacific Northwest Labs., Richland, WA (USA)). Feb 1979. Contract EY-76-C-06-1830. 133p. (PNL--2653-3). Dep. NTIS, PC A07/MF A01.

Progress is summarized in the following LWR safety-related studies: (1) ultimate heat sink performance measurements; (2) graphite nondestructive testing; (3) integration of nondestructive examination reliability and fracture mechanics; (4) acoustic emission-flaw relationship for in-service monitoring of pressure vessels; (5) experimental verification of steady state codes: ex-reactor determination of thermal gap and contact conductance, and irradiation results; (6) fuel subassembly procurement and irradiation test program; (7) steam generator tube integrity; and (8) core

thermal model development.

130 (NUREG/CR--0548) ICE BLOCKAGE OF WATER INTAKES. Carey, K.L. (Army Cold Regions Research and Engineering Lab., Hanover, NH (USA)). Dec 1978. 32p. NTIS, PC A03/MF A01.

The ice blockage of water intake structures can pose serious threats to the availability of cooling water at thermal power plants. Using information gained from a literature search and general knowledge of the problem, ice blockage difficulties are described as they may occur in rivers, lakes, reservoirs, and estuaries, and as they may affect intakes either at the surface or submerged. To further enable understanding of these problems, characteristics of both surface sheet ice and frazil ice are examined, namely, formational processes, sizes, thicknesses, movement or mobility, and modes of blockage or adhesion. Case histories of incidents of ice blockage of intakes are given by means of excerpts from the technical literature. Lastly, a brief overview is provided on the matter of solving ice blockage problems, either through original design, post-construction modification, or revised operational techniques.

131 (NUREG/CR--0637) THREADFIN SHAD IMPINGEMENT: EFFECT OF COLD STRESS ON A RESERVOIR COMMUNITY. ENVIRONMENTAL SCIENCES DIVISION PUBLICATION NO. 1198. McLean, R.B.; Griffith, J.S.; McGee, M.V.; Pasch, R. (Oak Ridge National Lab., TN (USA)). 1 Jan 1979. Contract W-7405-ENG-26. 64p. (ORNL/NUREG/TM--231). Dep. NTIS, PC A04/MF A01.

Biological and physical parameters influencing impingement rates of threadfin shad (Dorosoma pentenense) during October 1976--April 1977 at Kingston Steam Plant on Watts Bar Reservoir, Tennessee were identified and some ecological consequences of that impingement were assessed. Threadfin were found to comprise 97% of the 254,000 fish impinged, with about 25% of threadfin impingement occurring within 48 hr of a single one-day temperature decline from 8° to 3°C. Total threadfin impingement (2,391 kg) represents the equivalent standing crop of 328 cove hectares of the 15,783 hectare reservoir. These losses may have some effect on trophic dynamics in a normal year. Threadfin comprised 100% of the diet of sauger (a threadfin predator) from November 1976 to February 1977, at which time all threadfin disappeared due to a natural cold kill except for a remnant in the power plant discharge. Alternate prey were utilized to a limited extent during March and April. Digestion by sauger was significantly reduced at 5° and 10°C compared to that at 15°C but prey could still have been utilized if they had been available. The normal food web pathways were thus disrupted by the cold shock. Therefore, impingement in Watts Bar Reservoir during normal winters may be of some ecological consequence, but during severe winters environmentally-caused mortality may override effects of impingement mortality.

132 (NUREG/CR--0638) INCORPORATION OF SUBLETHAL EFFECTS AND INDIRECT MORTALITY IN MODELING POPULATION-LEVEL IMPACTS OF A STRESS, WITH AN EXAMPLE INVOLVING POWER-PLANT ENTRAINMENT AND STRIPED BASS. Van Winkle, W.; Christensen, S.W.; Suffern, J.S. (Oak Ridge National Lab., TN (USA)). 19 Mar 1979. Contract W-7405-ENG-26. 32p. (ORNL/NUREG/TM--288). Dep. NTIS, PC A03/MF A01.

The problems involved in including sublethal effects and indirect mortality in modeling the population-level impacts of a stress are discussed. Interactions of stressed individuals at one trophic level with those at the next lower and higher trophic levels are considered, particularly with reference to power plant entrainment as the source of stress. An equation is derived for the conditional mortality rate due to a stress that incorporates both direct and indirect mortality. Preliminary experiments to test for sublethal effects of heat shock on the feeding of striped bass (Morone saxatilis) larvae suggest that striped bass larvae may be less likely to feed following heat shocks of the type used in these experiments. However, once larvae do start feeding, these experiments suggest that the amount eaten is not substantially influenced by the preceding heat shock. The relationship between setting standards and modeling population-level impacts, and the use of application factors for each, are considered.

133 (NUREG/CR--0639) EMPIRICAL MODEL OF IMPINGEMENT IMPACT. ENVIRONMENTAL SCIENCES DIVISION PUBLICATION NO. 1289. Barnthouse, L.W.; DeAngelis, D.L.; Christensen, S.W. (Oak Ridge National Lab., TN (USA)). 9 Jan 1979. Contract W-7405-ENG-26. 28p. (ORNL/NUREG/TM--290). Dep. NTIS, PC A03/MF A01.

A simple model, derived from Ricker's (1975) theory of fisheries dynamics, that can be used to estimate the impact of impingement of juvenile fish by power plants on year-class abundance in vulnerable species is described. The only data required are estimates of the initial number of impingeable juveniles, the number impinged, and the rate of total mortality during the period of vulnerability. The impact of impingement is expressed in the model as the conditional mortality rate, rather than the more commonly used exploitation rate. The conditional mortality rate is superior as a measure of impact for two reasons: it accounts for the differential impact of impinging fish of different ages, and it is numerically equivalent to the fractional reduction in year-class abundance due to impingement. We present an application of the model using the 1974 year-class of the Hudson River striped bass population as an example. We then show how the model can be modified to account for seasonal fluctuations in the rate of impingement, discuss the effect of these fluctuations on the calculated impact, and discuss the influence on model output of errors in the measurement of abundance, impingement, and total mortality. It is evident from this analysis that estimates of impingement impact are as sensitive to errors in estimates of population size and mortality as to estimates of the number of fish impinged. Thus, it is not possible to reliably estimate the impact of impingement on a vulnerable fish species unless a substantial effort is devoted to population studies.

134 (NUREG/CR--0681) REACTOR SAFETY RESEARCH PROGRAMS. QUARTERLY REPORT, OCTOBER 1--DECEMBER 31, 1978. Hooper, J.L. (comp.). (Battelle Pacific Northwest Labs., Richland, WA (USA)). Feb 1979. Contract EY-76-C-06-1830. 118p. (PNL--2653-4). Dep. NTIS, PC A06/MF A01.

Progress is summarized in the following LWR safety-related studies: (1) ultimate heat sink performance measurements, (2) experimental verification of steady state codes, (3) core thermal model development, (4) fuel subassembly procurement and irradiation testing, (5) steam generator tube integrity, (6) acoustic monitoring of pressure vessels, and 7 integration of nondestructive examination

reliability and fracture mechanics.

135 (NUREG/CR--0770) ASBESTOS IN COOLING-TOWER WATERS. FINAL REPORT. Lewis, B.A.G. (Argonne National Lab., IL (USA)). Mar 1979. Contract W-31-109-ENG-38. 102p. (ANL/ES--71). Dep. NTIS, PC A06/MF A01.

Water discharges from cooling towers constructed with asbestos fill were found to contain chrysotile--asbestos fibers at concentrations as high as 10^6 fibers/liter. The major source of these fibers, appears to be the components of the towers rather than the air drawn through the towers or the makeup water taken into the towers. Suggested mechanisms for the release of chrysotile fibers from cooling-tower fill include freeze-thaw cycles and dissolution of the cement due to acidic components of the circulating water. Ash- or other material-settling ponds were found to reduce asbestos-fiber concentrations in cooling-tower effluent. The literature reviewed did not support the case for a causal relationship between adverse human health effects and drinking water containing on the order of 10^6 chrysotile--asbestos fibers/liter; for this and other reasons, it is not presently suggested that the use of asbestos fill be discontinued. However, caution and surveillance are dictated by the uncertainties in the epidemiological studies, the absence of evidence for a safe threshold concentration in water, and the conclusive evidence for adverse effects from occupational exposure. It is recommended that monitoring programs be carried out at sites where asbestos fill is used; data from such programs can be used to determine whether any mitigative measures should be taken. On the basis of estimates made in this study, monitoring for asbestos in drift from cooling towers does not appear to be warranted.

136 (NUREG/CR--0819) NUMERICAL MODELING OF ENTRAINMENT AND FAR FIELD THERMAL DISPERSION FOR NEP 1 AND 2, CHARLESTOWN, RHODE ISLAND. Isaji, T.; Spaulding, M. (Oak Ridge National Lab., TN (USA)). Jun 1978. Contract W-7405-ENG-26. 462p. (ORNL/NUREG/TM--325). Dep. NTIS, PC A20/MF A01.

A system of numerical models was developed which assessed the larvae entrainment into the intake and the far field thermal dispersion due to the cooling system operation of the proposed nuclear power plant NEP 1 and 2, Charlestown, Rhode Island. The hydrodynamics was simulated by a two dimensional, vertically averaged, finite element hydrodynamic model. The entrainment of winter flounder larvae was simulated by the finite element constituent transport model and the particle path model. The models predicted an entrainment of 4.7% under the proposed intake and diffuser operation. The diffuser return flow enhanced the entrainment by 20% compared with the intake operation only. The far field thermal dispersion for the proposeed heat discharge system was simulated with different conditions and parameters. Significant factors among the different conditions to be estimated were found to be the mixed layer depth and diffusion coefficient. The most probable case was simulated. The isotherm areas were 5609 acres for 1.0°C (1.8°F) and 1804 acres for 3.0°C (5.4°F).

137 (NUREG/CR--0835) TOXICITY AND EFFECTS OF BROMOFORM ON FIVE MARINE SPECIES. Gibson, C.I.; Tone, F.C.; Wilkinson, P.; Blaylock, J.W. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Jun 1979. Contract EY-76-C-06-1830. 15p. (PNL--3023). Dep. NTIS, PC A02/MF A01.

Bromoform has been identified as the single most abundant halogenated organic compound produced by the chlorination of marine waters. To determine the potential biological effects of its release into marine waters, short-term toxicity bioassays and 28-day uptake/28-day depuration studies were conducted with five marine species: Protothaca staminea, Mercenaria mercenaria, Crassostrea virginica, Penaeus aztecus, and Brevoortia tyrannus. The bioassay studies indicate that 96-hr LC_{50}'s ranged from approximately 7 ppM for B. tyrannus to greater than 40 ppM for P. staminea. The behavior of P. aztecus and B. tyrannus was significantly altered by exposure to bromoform.

138 (NUREG/CR--0855) REACTOR SAFETY RESEARCH PROGRAMS. QUARTERLY REPORT, JANUARY 1--MARCH 31, 1979. Hooper, J.L. (comp.). (Battelle Pacific Northwest Labs., Richland, WA (USA)). May 1979. Contract EY-76-C-06-1830. 171p. (PNL--3040-1). Dep. NTIS, PC A08/MF A01.

Progress is summarized in the following LWR safety-related studies: (1) ultimate heat sink performance; (2) verification of steady-state fuel performance computer codes; (3) acoustic emission-flow relationship for pressure vessel monitoring; (4) fuel subassembly procurement and irradiation; (5) steam generator tube integrity prediction; (6) core thermal model development; and (7) integration of nondestructive examination reliability and fracture mechanics. (HDR)

139 (NUREG/CR--1015) ANALYSIS OF POPULATIONS OF BORING AND FOULING ORGANISMS IN THE VICINITY OF THE OYSTER CREEK NUCLEAR GENERATING STATION. QUARTERLY PROGRESS REPORT, MARCH-MAY 1979. Hoagland, K.E.; Crocket, L.; Harms, J. (Lehigh Univ., Stone Harbor, NJ (USA). Wetlands Inst.). Oct 1979. 62p. NTIS, PC A04/MF A01.

The growth, distribution, and species composition of marine borers (primarily shipworms) and fouling organisms are being studied in the vicinity of the Oyster Creek Nuclear Generating Station, Barnegat Bay, New Jersey. Untreated wood test panels are used to collect organisms at 18 localities. Our most recent findings covering March-May 1979 are that at least one subtropical species of the borer family Teredinidae continues to live in Oyster Creek and Forked River. Despite dredging activity in Oyster Creek and unscheduled plant shutdowns, some T. bartschi survived. No settlement of larvae on one-month panels occurred. Much of the fouling in Oyster Creek died due to the dredging activities, and anoxic conditions occurred at stations 11 and 12. This illustrates the continued instability of the Oyster Creek-Forked River area since establishment of the Generating Station.

140 (ORAU/IEA--78-22(R)) ON TIME, INFORMATION, AND ENERGY CONSERVATION. Spreng, D.T. (Institute for Energy Analysis, Oak Ridge, TN (USA)). Dec 1978. Contract EY-76-C-05-0033. 36p. Dep. NTIS, PC A03/MF A01.

Time, information, and energy form a triad: to some degree each can be substituted for the other. Thus energy can be conserved if a process is performed more slowly, and therefore less irreversibly; or it can be conserved if sufficient information is available to monitor the energy-using device or system. This general relation between time, energy, and information is illustrated by analyses of the optimum size of a cooling tower in a power plant and the optimum thickness of thermal insulation. It is shown that lack of information and the desire

to save time often lead to designs that use more energy than the thermodynamic minimum. Economic and political limits to energy conservation are not primarily manufactured by the ''system'' but are imposed by basic facts of engineering and by preferences of most people.

141 (ORNL/EIS--145) OZONE IN AQUATIC SYSTEMS: A SELECTED, ANNOTATED BIBLIOGRAPHY. Adams, S.M.; Jolley, R.L.; Mattice, J.S.; Trabalka, J.R. (Oak Ridge National Lab., TN (USA)). Oct 1978. Contract W-7405-ENG-26. 86p. Dep. NTIS, PC A05/MF A01.

This bibliography, containing references on the chemistry and biological effects of ozone in aquatic systems, is part of an assessment of the literature of the environmental impact of power plant cooling systems. The references are arranged by subject category and indexes are provided for author, keywords, scientific name of test organism, location of study, and title (alphabetical listings of keywords-in-context of non-trivial words in the title).

142 (ORNL/TM--6131) COOLING TOWER DRIFT STUDIES AT THE PADUCAH, KENTUCKY GASEOUS DIFFUSION PLANT. Taylor, F.G.; Hanna, S.R.; Parr, P.D. (Oak Ridge National Lab., TN (USA)). Dec 1978. Contract W-7405-ENG-26. 40p. Dep. NTIS, PC A03/MF A01.

The transfer and fate of chromium from cooling tower drift to terrestrial ecosystems were quantified with concentrations in plant materials (fescue grass) decreasing with increasing distance from the cooling tower. Results indicate that elemental content in drift water (mineral residue) may not be equivalent to the content in the recirculating cooling water of the tower. This hypothesis is contrary to basic assumptions in calculating drift emissions. Results suggest that differences in retention in litter and foliage are related to chemical properties of the drift rather than physical lodging of the particle residue. To determine the potential for movement of drift-derived chromium to surface streams, soil-water samplers (wells) were placed along a distance gradient to Little Bayou Creek. Preliminary model estimates of drift deposition are compared to deposition measurements.

143 (ORNL/TM--6248) METEOROLOGICAL EFFECTS OF THERMAL ENERGY RELEASES (METER) PROGRAM. ANNUAL PROGRESS REPORT, OCTOBER 1976--SEPTEMBER 1977. Patrinos, A.A.; Hoffman, H.W. (comps.). (Oak Ridge National Lab., TN (USA)). Aug 1978. Contract W-7405-ENG-26. 320p. Dep. NTIS, PC A14/MF A01.

Separate abstracts were prepared for 12 sections of this report.

144 (ORNL/TM--6248, pp 9-40) PRECIPITATION STUDIES AROUND PLANT BOWEN. Patrinos, A.A.N.; Chen, N.C.J.; Miller, R.L. Aug 1978.

Meteorological Effects of Thermal Energy Releases (METER) Program. Annual progress report, October 1976--September 1977.

A program called METER (Meteorological Effects of Thermal Energy Releases) to investigate the atmospheric effects of the heat and moisture releases from large cooling towers and ponds, is reviewed. Results are reported from a precipitation modification study around the Plant Bowen (fossil-fuel power plant) in northwest Georgia which utilizes four natural-draft cooling towers. The study is composed of two parts: the statistical analysis of historic National Weather Service climatological data from the general area of the plant, and a field study involving, primarily, a high-density recording rain-gage network. Both parts are aimed toward obtaining quantitative estimates of potential plant-induced precipitation augmentation and storm pattern disruption.

145 (ORNL/TM--6248, pp 41-47) STUDIES OF THE ENVIRONMENTAL IMPACT OF EVAPORATIVE COOLING TOWER PLUMES. Thomson, D.W. (Pennsylvania State Univ., University Park). Aug 1978.

Meteorological Effects of Thermal Energy Releases (METER) Program. Annual progress report, October 1976--September 1977.

This ongoing research program of the environmental impact of natural-draft evaporative cooling tower plumes consists principally of a comprehensive series of airborne measurements of a variety of the physical characteristics of the plumes and, to a lesser extent, of preliminary studies of remote sodar plume probing techniques and the development of simplified dynamical numerical models suitable for use in conducting field measurement programs. The PSU Doppler sodar was used at the Keystone Power Plant in southwestern Pennsylvania for an extended series of remote measurements of the characteristics of plume turbulent temperature and velocity fluctuations and results are discussed.

146 (ORNL/TM--6248, pp 48-58) COOLING TOWER DRIFT: EXPERIMENT DESIGN FOR COMPREHENSIVE CASE STUDY. Laulainen, N.S. (Battelle Pacific Northwest Labs., Richland, WA). Aug 1978.

Meteorological Effects of Thermal Energy Releases (METER) Program. Annual progress report, October 1976--September 1977.

A drift experiment program to develop a data base which can be used for validation of drift deposition models has been formulated. The first field effort is designed for a suitable mechanical-draft cooling tower to be selected after site visits have been conducted. The discussion here demonstrates the importance of characterizing the droplet size spectrum emitted from the tower and to accurately account for droplet evaporation, because the downwind droplet deposition patterns and near-surface airborne concentrations are extremely sensitive to these parameters.

147 (ORNL/TM--6248, pp 59-66) COOLING POND FOG STUDIES. Hicks, B.B. (Argonne National Lab., IL). Aug 1978.

Meteorological Effects of Thermal Energy Releases (METER) Program. Annual progress report, October 1976--September 1977.

The Fog Excess Water Index (FEWI) method of fog prediction has been verified by the use of data obtained at the Dresden cooling pond during 1976 and 1977 and by a reanalysis of observations made in conjunction with a study of cooling pond simulators during 1974. For applications in which the method is applied to measurements or estimates of bulk water temperature, a critical value of about 0.7 mb appears to be most appropriate. The present analyses confirm the earlier finding that wind speed plays little part in determining the susceptibility for fog generation.

148 (ORNL/TM--6248, pp 69-132) REPORT ON ATDL RESEARCH ON METEOROLOGICAL EFFECTS OF THERMAL ENERGY RELEASES, AUGUST 1, 1976--SEPTEMBER 31, 1977. Hanna, S.R.; Rao, K.S.; Hosker, R.P. (National Oceanic and Atmospheric Administration, Oak Ridge, TN).

Aug 1978.
Meteorological Effects of Thermal Energy Releases (METER) Program. Annual progress report, October 1976--September 1977.
The ATDL plume and cloud growth model was applied to new sets of data from four separate sites and to contrived data as part of a sensitivity study. An experimental program was conducted in which time lapse photographs of cooling tower plumes in Oak Ridge, Tennessee, and Paradise, Kentucky, were taken and analyzed in order to determine the magnitudes of secondary motions. In addition, plume cross sections were drawn and analyzed using raw data from the Chalk Point Cooling Tower Project. The results of all these studies are summarized.

149 (ORNL/TM--6248, pp 168-183) DIFFERENCES IN ATMOSPHERIC CONVECTION CAUSED BY WASTE ENERGY REJECTED IN THE FORMS OF SENSIBLE AND LATENT HEATS. Koenig, L.R. (Rand Corp., Santa Monica, CA); Murray, F.W.; Tag, P.M. (Rand Corp., Santa Monica, CA). Aug 1978.
Meteorological Effects of Thermal Energy Releases (METER) Program. Annual progress report, October 1976--September 1977.
Results of this study indicate that atmospheric effects, such as the initiation or triggering of cumulus clouds, caused by cooling towers would be dependent on the size and gradient of the density perturbation created by the emissions contained in the tower plume. The size and gradient can be minimized if latent heat rather than sensible heat is rejected by the towers. Latent heat releases can be realized as sensible heat if the latent heat plume condenses, but if this occurs downwind of the tower after mixing with the environment has occurred, the density gradient will be reduced, and this should reduce overall effects. Thus, while dry towers would eliminate shadowing and drift (category II effects) that commonly occur at wet cooling tower sites, their use would increase the likelihood of atmospheric effects in the form of convective cloud initiation and associated effects such as rain anomalies. A cooling system rejecting solely latent heat might be ideal to minimize atmospheric effects (particularly if the plume could be made subsaturated), but such a device is not available to industry. A cooling pond may be a close substitute.

150 (ORNL/TM--6248, pp 184-210) MATHEMATICAL MODEL OF DRIFT DEPOSITION FROM A BIFURCATED COOLING TOWER PLUME. Chen, N.C.J.; Jung, L. Aug 1978.
Meteorological Effects of Thermal Energy Releases (METER) Program. Annual progress report, October 1976--September 1977.
Cooling tower drift deposition modeling has been extended by including centrifugal force induced through plume bifurcation in a crosswind as a mechanism for drift droplet removal from the plume. The model, in its current state of development, is capable of predicting the trajectory of a single droplet from the stage of strong interaction with the vortex field soon after droplet emission at the tower top through the stage of droplet evaporation in an unsaturated atmosphere after droplet breakaway from the plume. The computer program developed from the mathematical formulation has been used to explore the dependency of the droplet trajectory on droplet size, vortex strength, point of droplet emission, drag coefficient, droplet efflux speed, and ambient conditions. A specific application to drift from a mechanical-draft cooling tower (for a wind speed twice the efflux speed, a relative humidity of 70 per cent, and an initial droplet radius of 100 μm) showed the droplet to follow a helical trajectory within the plume, with breakaway occurring at 2.5 tower diameters downwind and ground impact of the droplet (reduced through evaporation to 55 μm radius) at 11 tower diameters.

151 (ORNL/TM--6248, pp 213-238) PLUMES FROM ONE AND TWO COOLING TOWERS. Kannberg, L.D.; Onishi, Y. (Battelle Pacific Northwest Labs., Richland, WA). Aug 1978.
Meteorological Effects of Thermal Energy Releases (METER) Program. Annual progress report, October 1976--September 1977.
Use of mechanical- and natural-draft cooling towers is expanding in the United States in response to pressures for better resource allocation and preservation. Specifically, increasing public and regulatory concern over the effects of the intake and discharge of large volumes of cooling water has encouraged electric utilities to accept cooling towers as the primary method of removing condenser waste heat even though once-through cooling is considerably less expensive. Other factors encouraging the use of cooling towers include small water supply and consumption rates, reduction in land requirements (compared to cooling ponds or lakes), and operational flexibility. The growing demand for electric energy should also add to the increase of cooling tower use. The experimental program and its comparison to model prediction suggest that optimal siting of cooling towers, particularly multiple towers, is a task requiring knowledge of ambient wind history, plume dynamics, and tower operating conditions. Based on the tower wake effects and on the results for interaction of plumes from two cooling towers, site terrain may be a very significant factor in plume dynamics and interaction.

152 (ORNL/TM--6248, pp 241-259) FIRE ANALOG: A COMPARISON BETWEEN FIRE PLUMES AND ENERGY CENTER COOLING TOWER PLUMES. Orgill, M.M. (Battelle Pacific Northwest Labs., Richland, WA). Aug 1978.
Meteorological Effects of Thermal Energy Releases (METER) Program. Annual progress report, October 1976--September 1977.
Past studies on the waste heat from thermal power plant cooling towers and proposed energy parks suggest that the dissipation of this waste energy may result in significant meteorological effects. Preliminary calculations have shown that the rate of atmospheric dissipation of the waste energy from groupings of cooling towers is approximately equal to that by geophysical phenomena such as thunderstorms, volcanoes, and large fires. Cumulus clouds and convective vortices often result from these natural energy releases. One of the geophysical analogs, the large fire, is evaluated in terms of how good a physical analog it is to cooling towers or groups of cooling towers. The literature on experimental and wild fires was reviewed in relation to how fire thermal plume characteristics may be typical of a thermal plume from cooling towers.

153 (ORNL/TM--6248, pp 263-272) LOCAL PRECIPITATION INCREASES CAUSED BY SCAVENGING OF COOLING TOWER PLUMES. Koenig, L.R. (Rand Corp., Santa Monica, CA). Aug 1978.
Meteorological Effects of Thermal Energy Releases (METER) Program. Annual progress report, October 1976--September 1977.
Quantitative estimates are provided of the precipitation increase in the vicinity of wet cooling towers as a result of plume-droplet

scavenging by natural rain. Rain rates from 1 to 5 mm/hr and wind speeds of 1 to 10 m/s are considered with source strength equal to moisture flux from a 1000-MW(e) power capacity. The increase in precipitation strongly depends on distance from the tower, wind speed, natural precipitation rate, source strength, and horizontal angle of plume spread. Under favorable conditions of light winds and steady rainfall, precipitation increases due to scavenging up to about 25 percent of the natural rate should occur as far as 1 km from plants as small as 1000 MW(e).

154 (ORNL/TM--6248, pp 273-297) RAINFALL ENHANCEMENT DUE TO SCAVENGING OF COOLING TOWER CONDENSATE. Dana, M.T. (Battelle Pacific Northwest Labs., Richland, WA); Wolf, M.A. Aug 1978.
Meteorological Effects of Thermal Energy Releases (METER) Program. Annual progress report, October 1976--September 1977.
The recent increase in the number of electrical generating plants that use cooling towers and projections for further expansion have prompted considerable concern about the environmental impact of large releases of energy and water effluent. One aspect of a comprehensive research program, Meteorological Effects of Thermal Energy Releases (METER), is an examination of the physical effects of the vast amounts of water vapor and condensate (tens of thousands of kilograms per second) regularly released by modern cooling towers. Such large releases can significantly affect water vapor and cloud-related natural processes, at least in the immediate vicinity. The question of precipitation scavenging of condensate droplets by natural precipitation and the resultant enhancement of precipitation under the plume is considered theoretically.

155 (ORNL/TM--6435) OFFSHORE HEAT DISSIPATION FOR NUCLEAR ENERGY CENTERS. Bauman, H.F. (Oak Ridge National Lab., TN (USA)). Sep 1978. Contract W-7405-ENG-26. 41p. Dep. NTIS, PC A03/MF A01.
The technical, environmental, and economic aspects of utilizing the ocean or other large water bodies for the dissipation of reject heat from Nuclear Energy Centers (NECs) were investigated. An NEC in concept is an aggregate of nuclear power plants of 10 GW(e) capacity or greater on a common site. The use of once-through cooling for large power installations offers advantages including higher thermal efficiencies, especially under summer peak-load conditions, compared to closed-cycle cooling systems. A disadvantage of once-through cooling is the potential for greater adverse impacts on the aquatic environment. A concept is presented for minimizing the impacts of such systems by placing water intake and discharge locations relatively distant from shore in deeper water than has heretofore been the practice. This technique would avoid impacts on relatively biologically productive and ecologically sensitive shallow inshore areas. The NEC itself would be set back from the shoreline so that recreational use of the shore area would not be impaired. The characteristics of a heat-dissipation system of the size required for a NEC were predicted from the known characteristics of a smaller system by applying hydraulic scaling laws. The results showed that adequate heat dissipation can be obtained from NEC-sized systems located in water of appropriate depth. Offshore intake and discharge structures would be connected to the NEC pump house on shore via tunnels or buried pipelines. Tunnels have the advantage that shoreline and beach areas would not be disturbed. The cost of an offshore heat-dissipation system depends on the characteristics of the site, particularly the distance to suitably deep water and the type of soil or rock in which water conduits would be constructed. For a favorable site, the cost of an offshore system is estimated to be less than the cost of a closed-cycle system.

156 (ORNL/TM--6523) METER-ORNL PRECIPITATION NETWORK: FROM DESIGN TO DATA ANALYSIS. Miller, R.L.; Saylor, R.E.; Patrinos, A.A.N. (Oak Ridge National Lab., TN (USA)). Oct 1978. Contract W-7405-ENG-26. 56p. Dep. NTIS, PC A04/MF A01.
The purpose of this Technical Memorandum is to record the development of the METER-ORNL precipitation network from the initial planning stages through the preliminary data analysis at present. The foremost objective of the field study is to resolve the question of Plant Bowen's potential effect on the precipitation patterns by means of extensive data analysis. Emphasis is placed on the importance of the thorough planning which has ensured the success of the field study. Discussions include: network design; procurement of equipment; public relations; siting, installation, and operation of equipment; data processing; and results of initial analysis. No conclusive precipitation effects can be attributed to Plant Bowen at this early stage of analysis.

157 (ORNL/TM--6533) WASTE HEAT REJECTION FROM GEOTHERMAL POWER STATIONS. Robertson, R.C. (Oak Ridge National Lab., TN (USA)). Dec 1978. Contract W-7405-ENG-26. 159p. Dep. NTIS, PC A08/MF A01.
This study of waste heat rejection from geothermal power stations is concerned only with the heat rejected from the power cycle. The heat contained in reinjected or otherwise discharged geothermal fluids is not included with the waste heat considered here. The heat contained in the underflow from the flashtanks in such systems is not considered as part of the heat rejected from the power cycle. By following this definition of the waste heat to be rejected, various methods of waste heat dissipation are discussed without regard for the particular arrangement to obtain heat from the geothermal source. Recent conceptual design studies made for 50-MW(e) geothermal power stations at Heber and Niland, California, are of particular interst. The former uses a flashed-steam system and the latter a binary cycle that uses isopentane. In last-quarter 1976 dollars, the total estimated capital costs were about $750/kW and production costs about 50 mills/kWhr. If wet/dry towers were used to conserve 50% of the water evaporation at Heber, production costs would be about 65 mills/kWhr.

158 (ORNL/TM--6867) METEOROLOGICAL EFFECTS OF THERMAL ENERGY RELEASES (METER) PROGRAM. ANNUAL PROGRESS REPORT, OCTOBER 1977-SEPTEMBER 1978. Patrinos, A.A.N.; Hoffman, H.W. (comps.). (Oak Ridge National Lab., TN (USA)). Jun 1979. Contract W-7405-ENG-26. 131p. Dep. NTIS, PC A07/MF A01.
Progress is reported in studies of the meteorological effects of thermal effluents from power plants. Information from six separate studies is presented. These studies involved: rainfall measurements near Plant Bowen in northwest Georgia; drift from mechanical draft cooling towers; environmental impact of evaporative plumes; temperature measurements of downwind plumes for plants having 3 or 4 mechanical draft cooling towers in flat terrain; the prediction of local

effects of cooling ponds; and self-precipitation of snow from cooling towers. (LCL)

159 (ORNL/TM--6883) STORMS OVER THE METER--ORNL PRECIPITATION NETWORK: THE FIRST SIX MONTHS. Miller, R.L.; Patrinos, A.A.N.; Saylor, R.E. (Oak Ridge National Lab., TN (USA)). Jun 1979. Contract W-7405-ENG-26. 55lp. Dep. NTIS, PC A24/MF A01.
This report presents the first set of data collected by the METER--ORNL Precipitation Network. This network of 49 recording raingages and 5 recording windsets was installed in February 1978, around the Bowen Electric Generating Plant in northwest Georgia for the purpose of investigating the potential effect of the plant's cooling towers on rainfall. This study is conducted on behalf of the DOE Program on Meteorological Effects of Thermal Energy Releases (METER). Included in this report are the complete descriptions of 98 rainfall events which occurred over the METER--ORNL network during the period February 22--August 31, 1978. These descriptions are augmented by information and data supplied by the National Weather Service (NWS). Several stratifications of the rainfall events are performed for reference purposes.

160 (PB--277058) EVALUATION OF PROPOSED TG AND E (TUCSON GAS AND ELECTRIC COMPANY) WASTEWATER DISCHARGE ON GROUNDWATER IN THE TUCSON BASIN. FINAL REPORT. Schmidt, K.D. (Schmidt (Kenneth D.), Fresno, CA (USA)). 30 Nov 1977. 73p. NTIS PC A04/MF A01.
The purpose of this investigation is to evaluate the probable impact of a proposed discharge of cooling tower blowdown wastewater on groundwater in the Tucson Basin. The sources of the wastewater is the Tucson Gas and Electric Company. About 740,000 gallons per day of wastewater are proposed to be discharged into an unnamed arroyo which eventually flows into the Santa Cruz River.

161 (PB--279032) DYNAMICS OF MANGANESE, CADMIUM, AND LEAD IN EXPERIMENTAL POWER PLANT PONDS. Mathis, B.J.; Cummings, T.F.; Gower, M.; Taylor, M.; King, C. (Illinois Univ., Urbana (USA). Water Resources Center; Bradley Univ., Peoria, IL (USA)). Jun 1977. 69p. (UILU-WRC--77-0125). NTIS PC A04/MF A01.
This study was designed to determine the effect of heated power plant cooling water on the compartmentalization of manganese, lead, and cadmium in experimental ponds. Caged channel catfish and green sunfish were kept in an experimental pond and a control pond. Periodically, whole fishes, gill, heart, kidney, liver, and musculature were analyzed for the three metals. Concentrations of the three metals in fishes were not affected by the temperature differential maintained during the study. There was no correlation in concentrations of cadmium and lead with age (weight and length) of fishes but manganese concentrations declined slightly with age. Aquatic organisms such as snails, fingernail clams, leeches, tubificid annelids, and dragonfly nymphs exhibited concentrations of cadmium higher than sediments while snails and duckweed more closely reflected concentrations of manganese in sediments.

162 (PB--279076) AIRBORNE MONITORING OF COOLING TOWER EFFLUENTS. VOLUME I. TECHNICAL SUMMARY. FINAL REPORT. Woffinden, G.J.; Harrison, P.R.; Anderson, J.A. (Meteorology Research, Inc., Altadena, CA (USA)). Apr 1978. 122p. NTIS PC A06/MF A01.
Meteorology Research, Inc. conducted an airborne plume monitoring program as part of the Chalk Point Cooling Tower Project. Plume measurements included: temperature, dew point, visibility, turbulence, droplet size distribution and concentration, liquid water content, sodium chloride concentration (NaCl), sulfuric acid concentration (H_2SO_4), and sulfur dioxide concentration (SO_2). Vertical cross sections of the plume were mapped at several downwind distances. Data were recorded every half second to provide the short response times required for accurate plume profile measurements. The presence of stable visible plumes was observed during cold high humidity conditions. Even under these conditions, the decrease in visibility is not considered to be a hazard to aircraft because of the limited distance over which it extends. Interactions between the cooling tower plume and the boiler plume are limited. The boiler plume is saturated with water from combustion products and from a venturi wet scrubber. Therefore, chemical reactions that require moisture have occurred prior to mixing with the cooling tower plume, and the additional water supplied by the cooling tower plume has little effect.

163 (PB--281602) POWER PLANT COOLING WATER CHLORINATION IN NORTHERN CALIFORNIA. EXTRAMURAL REPORT, 31 OCTOBER 1975--30 DECEMBER 1976. Hergott, S.; Jenkins, D.; Thomas, J.F. (California Univ., Berkeley (USA). Sanitary Engineering Research Lab.). Mar 1978. 78p. (UCB/SERL--77-3). NTIS PC A05/MF A01.
A survey was conducted of chlorination practices at five power plants owned and operated by the Pacific Gas and Electric Company. Frequency and duration of chlorination varied significantly from plant to plant and was controlled analytically by the orthotoluidine and/or amperometric methods. All the plants plan to change to using the amperometric method for future control purposes. In-plant studies were conducted during chlorination cycles to determine oxidant residuals at both the condenser inlets and at a point near the outfall. Both free and total oxidant residuals were measured amperometrically for most studies. The DPD-FAS method was included in later studies to gain a better understanding of the nature of the oxidant residual. These results indicated that most of the oxidant residual at the Hunters Point and Moss Landing power plants was bromine residual. Decay studies were conducted at the plant sites on the chlorinated cooling water collected at the outfall. The slowest decay was observed at the Contra Costa plant where the cooling water was the freshest. The most rapid decay was at the Hunters Point plant. The presence of sunlight increased the rate of decay at all locations.

164 (PB--282993) FIELD INVESTIGATION OF COOLING TOWER AND COOLING POND PLUMES. FINAL REPORT. West, R.E. (Colorado Univ., Boulder (USA). Dept. of Chemical Engineering). Apr 1978. 130p. NTIS PC A07/MF A01.
Measurements were made relating to the behavior of water-vapor plumes from forced-draft cooling towers and from cooling ponds. There were three categories of measurements. (1) Ambient weather data including temperature, humidity, wind speed and wind direction. These measurements were made with standard meteorological equipment. (2) Source data, including the temperature, mixing ratio and flowrate of the air leaving the cooling tower or cooling pond. Cooling-tower measurements were made with a traverse rig. Cooling-pond

source data were estimated using correlations. (3) Water-vapor distribution in the atmosphere in the vicinity of the source, including temperature and mixing ratio of air above the ground at various locations with respect to source. These measurements were made with tethered-balloon-borne radiosondes.

165 (PB--283218) PROGRESS ON RESEARCH ON OPEN CIRCULATING WATER COOLING SYSTEMS FOR LARGE ELECTRIC POWER PLANTS. PROGRESS REPORT NO. 1. Porter, R.W.; Lavan, Z.; Weinstein, H. (Illinois Inst. of Tech., Chicago (USA)). Oct 1975. 68p. NTIS PC A04/MF A01.

This study concerns the improvement of design procedures for spray canals. Problems studied include heat and mass transfer problems, controlling fluid-mechanical phenomena, multi-dimensional and turbulent diffusive processes, atmospheric interference, and the thermodynamic effectiveness of canals. It was determined that spray-canal performance may depend on additional parameters besides wind speed, water temperature, and wet-bulb temperature. The result is that winter conditions are more favorable than summer conditions even if other parameters are the same. Another area studied during this period was interference, which results in greater wet-bulb temperature.

166 (PB--283465) MATHEMATICAL METHODS TO EVALUATE ENTRAINMENT OF AQUATIC ORGANISMS BY POWER PLANTS. Goodyear, C.P. (National Plant Power Team, Ann Arbor, MI (USA)). Sep 1977. 25p. NTIS PC A02/MF A01.

Equations are presented which may be used to estimate the percentage loss of populations of aquatic organisms that are entrained by power plants located on rivers and streams, lakes and reservoirs, and estuaries. Important perameters that must be estimated to employ the techniques include the average concentration of organisms in the intake water and in the water body, the mortality of entrained organisms, and the average period organisms are vulnerable to entrainment.

167 (PB--284058) CHALK POINT COOLING TOWER PROJECT. VOLUME 1. SALT LOADING, MODELING, AND AIRCRAFT HAZARD STUDIES. FINAL REPORT 1 JULY 1976--30 JUNE 1977. (Johns Hopkins Univ., Silver Spring, MD (USA). Applied Physics Lab.). Aug 1977. 359p.

A preliminary estimate of salt loading impact due to drift from the Chalk Point cooling tower indicates that the annual salt loading is a maximum of 64 kg/hectare at a distance of approximately 0.5 km from the tower and less than 5 kg/hectare at all off-site locations (on land). These off-site values are much less than the 20 kg/hectare/month deposition rate which the University of Maryland designated as the growing season level below which there is no noticeable effect on corn, soybeans, and tobacco. It is tentatively concluded that the cooling tower poses no significant threat to commercial agriculture. The preliminary nature of these estimates is carefully discussed in the text. A comparative study of various drift models has been made and an input paremeter sensitivity analysis has been conducted. Sensitivities to drop size distribution and uncertainty in various input data errors have also been conducted and are reported. A tentative selection of the Israel-Overcamp model and the APL models for further detailed use in the model validation program is described. The possible hazard which a cooling tower plume may pose to aircraft flight has been investigated. It is concluded that hazard due to low visibility and aircraft engine or airframe icing is negligible.

168 (PB--284059) CHALK POINT COOLING TOWER PROJECT. VOLUME 2. COOLING TOWER DRIFT DYE TRACER EXPERIMENT, JUNE 16 AND 17, 1977. FINAL REPORT 1 JULY 1976--30 JUNE 1977. (Johns Hopkins Univ., Silver Spring, MD (USA). Applied Physics Lab.). Aug 1977. 95p.

A drift dye tracer experiment, using Rhodamine (WT) dye, was conducted on airborne drift from a natural draft cooling tower at PEPCO's Chalk Point, Maryland Power Generating Station. This experiment was designed to separate and identify cooling tower aerosol deposition from other sources and to provide a data base for use in cooling tower salt loading and model validation. Prior to the experiment, laboratory tests showed that Rhodamine (WT) was inexpensive, safe and controllable when used as a drift dye tracer. Positive identification and separation of cooling tower drift can be made among other sources using a dye tracer.

169 (PB--284060) CHALK POINT COOLING TOWER PROJECT. VOLUME 3. COOLING TOWER DRIFT DYE TRACER EXPERIMENT SURFACE WEATHER AND AMBIENT ATMOSPHERIC PROFILE DATA, JUNE 16 AND 17, 1977. FINAL REPORT 1 JULY 1976--30 JUNE 1977. (Johns Hopkins Univ., Silver Spring, MD (USA). Applied Physics Lab.). Aug 1977. 187p.

During the Chalk Point Cooling Tower Drift Dye Tracer Experiment, meteorological data was taken at Chalk Point. This report is a compilation of that data and surface weather observations made at Andrew's Air Force Base and Patuxent Naval Air Station. The compilation contains the hourly surface weather observations and the rawinsonde data taken at Chalk Point, Maryland on June 16 and 17, 1977. The rawinsonde data is presented in both tabular and graphical form. The surface weather observations are presented just in tabular form.

170 (PB--284075) CHALK POINT COOLING TOWER PROJECT: COOLING TOWER EFFECTS ON CROPS AND SOILS. PREOPERATIONAL REPORT. REPORT FOR APRIL 1973--APRIL 1975. Mulchi, C.L.; Wolf, D.C.; Foss, J.E.; Armbruster, J.A. (Maryland Univ., College Park (USA). Water Resources Research Center). Mar 1976. 108p. NTIS PC A06/MF A01.

The objectives of the Chalk Point Cooling Tower Project are to monitor the effects of saline aerosol drift originating from the stacks and natural draft cooling towers associated with Units No 3 and 4 at the Chalk Point Electric Generating Station operated by PEPCO. This report summarizes baseline dustfall and SO^2 data obtained on a monthly basis over the period April, 1973 - April, 1975 from 12 monitoring sites. Each monitoring site is approximately 0.4 ha in area and has three replicated plots established for monitoring yields and chemical characteristics of major agricultural crops (corn, soybeans, tobacco, wheat, oats, barley), dustfall collectors, sulfation plates, a raingauge and an undisturbed site for monitoring changes in the chemical and physical properties of soils. (Color illustrations reproduced in black and white)

171 (PB--284076) CHALK POINT COOLING TOWER PROJECT: COOLING TOWER EFFECTS ON CROPS AND SOILS. PREOPERATIONAL REPORT, APPENDIX. REPORT FOR APRIL 1973--APRIL 1975. Mulchi, C.L.; Wolf, D.C.; Foss, J.E.; Armbruster, J.A. (Maryland Univ., College Park (USA). Water

Resources Research Center). Apr 1976. 97p. NTIS PC A05/MF A01.

This report contains data collected on a monthly basis over the period April, 1973 - April, 1975 for dustfall particulates, sodium and chloride and SO2 levels obtained from 12 monitoring sites near the Chalk Point Generating Station operated by PEPCO and located 65 km south-southeast of Washington, D.C. on the Patuxent River in Maryland. Information on rainfall amounts, acidity and salinity; soil chemical analyses; yield and quality of major crops; and chemical analyses of vegetative samples from seven crop species for 1973 and 1974 growing seasons are reported. Also included in this report are summaries of experiments conducted at the Tobacco Experimental Farm near Upper Marlboro, Md. involving the simulation of salt spray drift on tobacco, corn and soybeans. Crops yields and quality and chemical analyses of vegetative samples are reported.

172 (PB--264077) CHALK POINT COOLING TOWER PROJECT: COOLING TOWER EFFECTS ON CROPS AND SOILS. POSTOPERATIONAL REPORT NO. 1, VOLUME 1. FINAL REPORT, MAY 1975--APRIL 1976. Mulchi, C.L.; Wolf, D.C.; Foss, J.E.; Armbruster, J.A. (Maryland Univ., College Park (USA). Water Resources Research Center). Jun 1976. 61p. NTIS PC A04/MF A01.

The natural draft cooling tower on Unit No 3 at the Chalk Point Generating Station, operated by PEPCO, became operational in July, 1975. This report contains a summary of information obtained on a monthly basis over the period May, 1975 - March, 1976 for dustfall particulates, sodium and chloride; SO2; rainfall amounts, acidity and salinity; yields and quality for major agricultural crops (corn, tobacco and soybeans); and chemical analyses of vegetative and soil samples obtained during the 1975 growing season. Several years of data appears necessary before specific effects due to salt drift can be assessed.

173 (PB--264078) CHALK POINT COOLING TOWER PROJECT: COOLING TOWER EFFECTS ON CROPS AND SOILS. POSTOPERATIONAL REPORT NO. 1, VOLUME 2. FINAL REPORT MAY 1975-APRIL 1976. Mulchi, C.L.; Wolf, D.C.; Foss, J.E.; Armbruster, J.A. (Maryland Univ., College Park (USA). Water Resources Research Center). Jun 1976. 38p. NTIS PC A03/MF A01.

This report contains summaries of experiments involving the effects of simulated salt drift on corn, tobacco and soybeans which were conducted during the summer of 1975 at the Tobacco Experimental Farm near Upper Marlboro, Md. Brackish water utilized in these studies was obtained from the Unit No 3 cooling tower at Chalk Point Generating Station opened by PEPCO. The water, which varied in total salinity from 8.6 to 14.0 ppt, was applied as 100 micron droplets for five days per week for eight weeks at rates of 0, 17.1, 34.2 and 51.3 l/ha/day. When treatments were terminated, yields and chloride contents of cured tobacco were found to be increased by treatments. Also contained in this report are results from studies concerning the effects of nitrogen sources on the response of tobacco to soil chloride additions. Trends for increased yields and values were found with increased soil chloride additions and for nitrate nitrogen. Leaf burn was negatively correlated with leaf chloride levels. Data on the movement of NaCl through soils and the effects of salt-sprayed soybean residue on soil respiration rates was presented and discussed.

174 (PB--284094) CHALK POINT COOLING TOWER PROJECT: COOLING TOWER EFFECTS ON CROPS AND SOILS. POST OPERATIONAL REPORT NO. 2. FINAL REPORT FY 1977. Mulchi, C.L.; Wolf, D.C.; Foss, J.E.; Armbruster, J.A. (Maryland Univ., College Park (USA). Water Resources Research Center). Aug 1977. 139p. NTIS PC A07/MF A01.

This report contains a summary of monthly dustfall, SO^2, rainfall, crops and soils information obtained over the period May, 1976 to March, 1977 from 12 monitoring sites near the Chalk Point Generating Station operated by PEPCO which is located 65 km south-southeast of Washington, D.C. on the Patuxent River in Maryland. The report also contains a comprehensive comparison of monitoring data collected over two-year periods prior to and following, respectively, the initiation of operations of Unit No 3 natural-draft cooling tower at Chalk Point. Chemical analyses of vegetative and soil samples collected following initiation of cooling tower operations have been variable with some increases in tissue chlorides in crops being observed. Changes in crop yields have been more attributable to natural environmental conditions than to salt stress.

175 (PB--284211) CHALK POINT COOLING TOWER PROJECT: CHALK POINT SURFACE WEATHER AND AMBIENT ATMOSPHERIC PROFILE DATA, SEPTEMBER--DECEMBER 1975. Meyer, J.H.; Jenkins, W.R. (Johns Hopkins Univ., Laurel, MD (USA). Applied Physics Lab.). Jul 1976. 204p. NTIS PC A10/MF A01.

This report is a compilation of the Chalk Point surface weather and ambient atmospheric profile data for the months of September to December 1975. The atmospheric profiles were made using rawinsonde instrumentation. The compilation includes the 0700 EST daily weather chart, hourly surface observations from Chalk Point, Patuxent River Naval Test Center, Maryland and Andrews Air Force Base, Maryland. Temperature, relative humidity, dew point, wind speed and wind direction are presented in graphical profiles. All other data are presented in tabular form.

176 (PB--284212) CHALK POINT COOLING TOWER PROJECT: CHALK POINT SURFACE WEATHER AND AMBIENT ATMOSPHERIC PROFILE DATA; FIRST INTENSIVE TEST PERIOD, DECEMBER 15-19, 1975, REVISION. Meyer, J.H. (Johns Hopkins Univ., Silver Spring, MD (USA). Applied Physics Lab.). Dec 1976. 239p.

This report is a compilation of the Chalk Point surface weather and ambient atmospheric profile data for the first intensive test period, December 15-19, 1975. The atmospheric profiles were made using rawinsonde instrumentation. The compilation includes the 0700 EST daily weather chart, hourly surface observations from Chalk Point, Patuxent River Naval Test Center, Maryland and Andrews Air Force Base, Maryland. Temperature, relative humidity, dew point, wind speed and wind direction are presented in graphical profiles. All other data are presented in tabular form.

177 (PB--284213) CHALK POINT COOLING TOWER PROJECT: CHALK POINT SURFACE WEATHER AND AMBIENT ATMOSPHERIC PROFILE DATA; SECOND INTENSIVE TEST PERIOD, JUNE 14-24, 1976. Meyer, J.H.; Jenkins, W.R. (Johns Hopkins Univ., Laurel, MD (USA). Applied Physics Lab.). Jan 1977. 728p. NTIS PC A99/MF A01.

This report is a compilation of the Chalk Point surface weather and ambient atmospheric profile data for the second intensive test

period, June 14-24, 1976. The atmospheric profiles were made using rawinsonde instrumentation. The compilation includes the 0700 EST daily weather chart, hourly surface observations from Chalk Point, Patuxent River Naval Test Center, MD and Andrews Air Force Base, MD. Temperature, relative humidity, dew point, wind speed and wind direction are presented in graphical profiles. All other data are presented in tabular form.

178 (PB--284214) CHALK POINT COOLING TOWER PROJECT: EFFECTS OF SIMULATED SALINE COOLING TOWER DRIFT ON WOODY SPECIES. MASTER'S THESIS. Francis, B.A. (Johns Hopkins Univ., Laurel, MD (USA). Applied Physics Lab.). Jul 1977. 87p. NTIS PC A05/MF A01.

Cooling towers of power plants are used to dissipate waste heat into the atmosphere. If saline water is used for cooling, a saline aerosol known as drift is released into the atmosphere. Drift effects on vegetation are not well known. To simulate drift for a field study, cooling tower basin water was sprayed thirty separate times during a 46-day period in 1975 on Virginia pine (Pinus virginiana), flowering dogwood (Cornus florida), tulip tree (Liriodendron tulipfera), and California privet (Ligustrum ovalifolium), Norway spruce (Picea abies), and white ash (Fraxinus americana) were added in 1976 and all trees were sprayed 43 times during a 59-day period. Only dogwood leaves showed significant injury. Absence of injury on other species was probably due to the ability of their leaves to exclude, or reduce absorption of, toxic concentrations of the ions supplied.

179 (PB--284826) CHALK POINT COOLING TOWER PROJECT. VOLUME I, PHASE V. ANALYSIS AND ARCHIVING PROGRAM, FY77. FINAL REPORT, 1 JULY 1976--31 AUGUST 1977. Margetts, M.J. (Environmental Systems Corp., Knoxville, TN (USA)). May 1978. 336p. NTIS PC A15/MF A01.

Results of field measurements and data analysis as part of the Chalk Point Cooling Tower Project (CPCTP) for the Fiscal Year 1977, are presented in two volumes. Volume 1 contains results from the following program areas: (1) Chalk Point Meteorological Tower operation including summaries of meteorological data for the site; (2) Scheme for archiving the Chalk Point data sets; (3) Analysis of cooling tower emission data, ambient salt concentration data, and plume photography; and (4) Modeling including a model survey, preliminary model sensitivity work and an examination of Chalk Point data for consistency and sufficiency for modeling. (Portions of this document are not fully legible)

180 (PB--284827) CHALK POINT COOLING TOWER PROJECT. VOLUME 2. COOLING TOWER DRIFT DYE TRACER EXPERIMENT, FY77. FINAL REPORT, 1 JULY 1976--31 AUGUST 1977. Margetts, M.J. (Environmental Systems Corp., Knoxville, TN (USA)). Dec 1977. 112p. NTIS PC A06/MF A01.

A description and results of ESC's participation in the Chalk Point Cooling Tower Project Dye Tracer Experiment is presented together with reduced data. Measurements were conducted during two data acquisition periods on the afternoon and evening of June 16, 1977, at PEPCO's Chalk Point Generating Station. Data were acquired in four major areas: (1) Unit Number 3 Cooling Tower Emission Characterization; (2) Meteorological Tower Data; (3) Ground-Level Measurements; (4) Plume Photography. In addition, Unit Number 3 power generation data for the test period are included as summarized from PEPCO's log and are given in Section E of each Appendix. The measurements were performed successfully without major problems. Results of the measurements are compared with the results of the CPCTP Summer Seasonal Test conducted in June 1976.

181 (PB--285126) WATER FOR POWER PLANT COOLING. (California Dept. of Water Resources, Sacramento (USA)). Jul 1977. 54p. NTIS PC A04/MF A01.

Future demands for cooling water needed for the production of electrical energy; possible sources of cooling water, including agricultural and municipal waste water, brackish and saline interior water, geothermal water, ground water, and fresh surface water; and the various methods of power plant cooling are discussed. Plans by California electric utilities to obtain supplies of cooling water for four proposed inland power plants are noted.

182 (PB--285397) WATER CONSUMPTION AND COSTS FOR VARIOUS STEAM ELECTRIC POWER PLANT COOLING SYSTEMS. FINAL REPORT, OCTOBER 1977--JANUARY 1978. Hu, M.C.; Pavlenco, G.F.; Englesson, G.A. (Cameron Engineers, Inc., Denver, CO (USA)). Aug 1978. Contract EPA-68-01-4337. 140p. NTIS PC A07/MF A01.

The report gives results of a state-of-the-art study, addressing consumptive water use and related costs of various steam electric power plant cooling systems, the availability of water for all uses by area, and the impact of legal constraints on water use in the U.S.

183 (PB--285924) OPTIMIZATION OF DESIGN SPECIFICATIONS FOR LARGE DRY COOLING SYSTEMS. FINAL REPORT, JUNE 1975--JUNE 1978. Rozenman, T.; Fake, J.M.; Pundyk, J.M. (Mid-Pacific Marine Lab., Kaneohe, HI (USA)). Jul 1978. Contract EPA-68-03-2215. 315p. NTIS PC A16/MF A01.

The report presents a methodology for optimizing design specifications of large, mechanical-draft, dry cooling systems. A multivariate, nonlinear, constrained optimization technique searches for the combination of design variables to determine the cooling system with the lowest annual cost. Rigorous formulations are used in calculating heat transfer and fluid flow. All thermal and mechanical design variables of the cooling system components are analyzed. Thermal variables include ambient air temperature, condenser terminal temperature difference, cooling range, and initial temperature difference. Module variables are tube length, number of rows and passes, and fan power. The methodology employs a computer program with major computational blocks written as subroutines. The program optimizes dry towers with either surface condensers or direct-contact jet condensers. Results of detailed parametric and sensitivity analyses are presented. The relationships of design variables, major components, site variables, and utility economic factors to incremental annual costs are examined for 1000 MWe fossil fuel plants at five U.S. sites. Results, presented in both graphs and tables, show that all design variables affect cooling system cost.

184 (PB--286364) MATHEMATICAL MODEL FOR MULTIPLE COOLING TOWER PLUMES. FINAL REPORT. Wu, F.H.Y.; Koh, R.C.Y. (California Inst. of

Tech., Pasadena (USA). W.K. Kellogg Radiation Lab.). Jun 1978. 133p. NTIS PC A07/MF A01.

A mathematical model is developed for the prediction of plume properties such as excess plume temperature, humidity and liquid phase moisture (water droplet), plume trajectory, width, and dilution at the merging locations and the beginning and ending points of the visible part of the plumes. Detailed printout and contour plots of excess temperature and moisture distribution can also be obtained if desired. Based on comparison with laboratory data this model gives good predictions for the case of dry plumes (no moisture involved). It should be noted that several empirical coefficients are as yet not accurately known. Verification of this model for the wet plume (such as for prototype cooling tower plumes) and the determination of the values for these empirical coefficients to be used in prototype applications must await detailed comparison with field data.

185 (PB--286629) LARVAL FISH DISTRIBUTIONS IN SOUTHWESTERN LAKE ERIE NEAR THE MONROE POWER PLANT. REPORT FOR 1 APRIL 1976-1 APRIL 1978. Cole, R.A. (Michigan State Univ., East Lansing (USA). Inst. of Water Research). Jul 1978. 76p. NTIS PC A05/MF A01.

This paper presents and discusses studies of larval fish distribution near a large power plant on western Lake Erie using methods that attempt to account for the confounding effect of environmental variation on technique effectiveness. Distributions in the coastal zone were sampled with daytime and nighttime tows of 1-m plankton nets. Density and mortality were also sampled in the cooling system of the Monroe Power Plant. Certain species of larvae seemed to be more vulnerable to entrainment than others: gizzard shad were more vulnerable than yellow perch, white bass, rainbow smelt, shiners (Notropis) carp and goldfish.

186 (PB--286758) COOLING TOWER EFFECTS ON NATIVE PERENNIAL VEGETATION. AUGUST 1972-APRIL 1975. VOLUME I. SECTIONS I-IX. PREOPERATIONAL REPORT. Curtis, C.R.; Lauver, T.L.; Francis, B.A. (Maryland Univ., College Park (USA). Water Resources Research Center). Apr 1976. 64p. NTIS PC A04/MF A01.

This document represents a summary of studies on perennial vegetation completed during the period August, 1972-April, 1975 which preceded the initiation of cooling tower operations at Chalk Point, Maryland. The study gives variables in soils, annual vegetation, and perennial vegetation under conditions prevalent prior to completion and operation of the cooling tower. Also these variables are given after the towers became operational. Environmental impact of saline drift on the surrounding area is reported with particular attention to tobacco and other agronomic crops, on perennial vegetation, and on soils of the vicinity. (Color illustrations reproduced in black and white)

187 (PB--286931) IMPACTS OF TRANSMISSION LINES ON BIRDS IN FLIGHT. PROCEEDINGS OF A WORKSHOP HELD AT OAK RIDGE ASSOCIATED UNIVERSITIES, OAK RIDGE, TENNESSEE ON 31 JANUARY--2 FEBRUARY 1978. Avery, M.L. (National Plant Power Team, Ann Arbor, MI (USA)). Sep 1978. 160p. NTIS PC A08/MF A01.

The proceedings of this 3-day workshop address the impacts to birds of the proliferation of power lines, cooling towers, tall stacks, radio and TV towers, and tall buildings. The eight invited papers included in the proceedings examine the extent of the problem, review available knowledge, discuss specific examples, and identify research needs on the impacts of electric power transmission lines on local and migratory movements of birds. Reports from working groups on behavior, habitat, migration, management options, and research priorities, and an extensive bibliography are included.

188 (PB--287834) APPENDIX TO ENTRAINMENT AT A ONCE-THROUGH COOLING SYSTEM ON WESTERN LAKE ERIE. VOLUME II. APPENDICES. FINAL REPORT 1 SEP 72-31 DEC 75. Cole, R.A. (Michigan State Univ., East Lansing (USA)). Aug 1978. 258p. NTIS PC A12/MF A01.

The report is a compilation of data for Entrainment at a Once-Through Cooling System on Western Lake Erie.

189 (PB--287862) FACTORS AFFECTING ACCURACY OF ICHTHYOPLANKTON SAMPLES USED IN POWER PLANT ENTRAINMENT STUDIES. TOPICAL BRIEFS REPORT. Bowles, R.R.; Merriner, J.V.; Boreman, J. (National Plant Power Team, Ann Arbor, MI (USA); Virginia Inst. of Marine Science, Gloucester Point (USA)). Jun 1978. 19p. NTIS PC A02/MF A01.

Sampling programs designed to assess impact of power plants on ichthyoplankton populations are subject to multiple sources of error that may affect reliability and applicability of the data. Gear currently used to sample ichthyoplankton are discussed, and abiotic and biotic factors that may prevent these gear from attaining representative samples are identified. A check list of items which should be considered in evaluation of existing or proposed programs to sample ichthyoplankton is provided.

190 (PB--289163) CHALK POINT COOLING TOWER PROJECT NATIVE VEGETATION STUDY. FINAL REPORT, 1 JULY 1977-30 JUNE 1978. Patterson, G.W.; Curtis, C.R.; Lauver, T.L.; Hosokawa, G. (Maryland Univ., College Park (USA). Water Resources Research Center). Jun 1978. 241p. NTIS PC A11/MF A01.

This program is a monitoring study of foliar sodium and chloride in four different native tree species growing in the vicinity of the Chalk Point Power Plant. The sampling areas are composed of a total of 12 tree sites with ten marked trees per site. The data reported cover leaf chloride values determined for foliage which was sampled monthly from May 1977 to September 1977. These Cl^- data are presented in a reduced graphic form showing monthly trends and in a more detailed tabular listing Cl^- values for the individual trees.

191 (PB--289271) CHALK POINT COOLING TOWER PROJECT: COOLING TOWER EFFECTS ON CROPS AND SOILS. POST OPERATIONAL REPORT NO. 3. FINAL REPORT, 1 JULY 1977-30 JUNE 1978. Mulchi, C.L.; Wolf, D.C.; Armbruster, J.A. (Maryland Univ., College Park (USA). Water Resources Research Center). Jul 1978. 107p. NTIS PC A06/MF A01.

This report contains a summary of dustfall, rainfall, crops and soils information obtained from a network of 12 research sites which are located within a 9.6 km radius of an operational natural draft cooling tower at Chalk Point, Md. during the period 4/77 - 4/78. Results from previous years which included two years of preoperational (4/73 - 4/75) and two years of postoperational (5/75 - 3/77) data

were compared with the present information. This report also contains summaries of agronomic and chemical data obtained from experiments involving the effects of soil and foliar applied salts on tobacco, corn, and soybeans in plots located at the University of Maryland's Tobacco Experimental Farm.

192 (PB--289372) COMPUTING EVAPORATION FOR INLAND WATER BODIES UNDER A VARIETY OF FETCH AND ATMOSPHERIC STABILITY CONDITIONS. TECHNICAL COMPLETION REPORT. Taylor, S.L.; DeWalle, D.R. (Pennsylvania State Univ., University Park (USA). Inst. for Research on Land and Water Resources). Nov 1978. Contract DI-14-34-0001-7128. 76p. NTIS PC A05/MF A01.

An equation is developed to predict evaporation from inland water bodies which accounts for the effects of atmospheric stability and fetch length. The equation contains a term representing free convection, forced convection, and the interaction of forced and free convection. Data sets from lake and cooling pond evaporation studies, e.g. Lake Hefner (Oklahoma), Smithers Lake (Texas), and Hazelwood (Australia) cooling ponds, were used to derive empirical coefficients and initially test the equation. The equations were also compared using data from a thermally-loaded reach of the West Branch Susquehanna River in Pennsylvania. Although evaporation predictions using both the Ryan and Harleman equation and the proposed equation were similar for conditions for which they were derived, the proposed equations proved to be more accurate over a wider range of thermal loading and fetch length conditions.

193 (PB--289586) COMPARISON OF SIMULATION MODELS USED IN ASSESSING THE EFFECTS OF POWER-PLANT-INDUCED MORTALITY ON FISH POPULATIONS. TECHNICAL REPORT. Swartzman, G.L.; Deriso, R.B.; Cowan, C. (Washington Univ., Seattle (USA). Center for Quantitative Science in Forestry, Fisheries, and Wildlife). Oct 1978. Contract NRC-04-75-222. 169p. NTIS PC A08/MF A01.

Eight models predicting the impact of power plant operation upon economically important fish species are compared. The paper focuses on the effect differences between the models have on model predictions. Generalized model simulators were developed for the young-of-the-year and life-cycle submodels. Criteria used to evaluate model predictions are percentage of reduction in young-of-the-year and annual loss in yield to the fishery due to plant operation. Major differences between the models include the life stage lengths, density-dependent or density-independent young-of-the-year fish to age class 1. Major differences in parameter values include entrainment factors, total egg production, equilibrium population size, and survival probabilities for the life-cycle models. Recommendations are made regarding our preference for model approaches.

194 (PB--290576) OPTIMUM COMBINATIONS OF COOLING ALTERNATIVES FOR STREAM - ELECTRIC POWER PLANTS. VOLUME II. FINAL REPORT. Crcley, T.E.; Giaquinta, A.R.; Lee, R.M.H.; Hsu, T. (Iowa Inst. of Hydraulic Research, Iowa City (USA)). Jul 1978. Contract DI-14-31-0001-5201. 185p. NTIS PC A09/MF A01.

An overview of cooling alternatives and detailed system thermodynamics are presented. Two sets of computer models are developed for the analysis of wet tower/cooling pond and wet tower/once-through combination cooling systems. The models are used to study the thermal characteristics, economics, and water consumption of these combination cooling systems. The effects of both meteorological conditions and economic parameters such as various unit costs, are examined in the identification of optimum cooling system configurations for several case studies. The case studies illustrate the most promising cooling system configurations or types of combined cooling systems, which are attractive in their economic or water conservation aspects. It is found that the parallel water path configuration of the wet tower/cooling pond combination cooling system is economically superior to the series water path configurations. For the wet tower/once-through combination cooling system, the type 3 cooling system (which is a series water-path arrangement with a partially closed-cycle loop) appears to be the most attractive one. Comparison of the dry/wet tower system with the wet tower/cooling pond system indicates that the latter is economically superior but has higher water consumption. Finally, it is evident that combination wet tower/once-through cooling systems are economical in comparison with once-through cooling associated with low river heat assimilation capacity.

195 (PB--290858) ASSESSING THE IMPACT OF NUCLEAR-POWER PLANTS ON THE ENVIRONMENT. ANNUAL PROGRESS REPORT NO. 2. Chapman, D.G.; Lettenmaier, D.P.; Seymour, A.H.; Swartzman, G.L.; Lawson, H.E. (Washington Univ., Seattle (USA). Center for Quantitative Science in Forestry, Fisheries, and Wildlife). Feb 1979. Contract NRC-04-75-222. 184p. NTIS PC A09/MF A01.

The report assesses the wide-ranging effects that nuclear-power plants can have on the environment, which include (1) mortality to fish and other organisms resulting from impingement and entrainment in the cooling system, (2) changes in behavioral and physiological characteristics of aquatic animals by higher temperatures present in the discharge plume and (3) toxic effects of biocides, heavy metals and radionuclides released in the aquatic or atmospheric environment.

196 (PNL--2500(Pt.3), pp 2.37-2.38) COOLING TOWER DRIFT: EXPERIMENT DESIGN FOR COMPREHENSIVE CASE STUDY. Laulainen, N.S. Feb 1978.

Pacific Northwest Laboratory annual report for 1977 to the DOE Assistant Secretary for Environment. Part 3. Atmospheric sciences.

A comprehensive experimental study of drift emissions and deposition from a mechanical draft cooling tower is planned for early spring 1978. The field effort is to measure rates of mineral mass and drift water emissions and depositions downwind from a suitable power plant. Measurements of drift droplet size distributions, cooling tower temperature and velocity profiles, and ambient meteorological parameters are also to be made. From these measurements, a data base can be developed which can be used for validating models of drift deposition from cooling towers.

197 (PNL--2500(Pt.3)) PACIFIC NORTHWEST LABORATORY ANNUAL REPORT FOR 1977 TO THE DOE ASSISTANT SECRETARY FOR ENVIRONMENT. PART 3. ATMOSPHERIC SCIENCES. Simpson, C.L. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Feb 1978. Contract EY-76-C-06-1830. 156p. Dep. NTIS, PC A08/MF A01.

Separate abstracts were prepared for the 54 papers included in the report. (HLW)

198 (PNL--2500(Pt.3), pp 2.39-2.40) RAINFALL ENHANCEMENT DUE TO WASHOUT OF COOLING TOWER CONDENSATE. Dana, M.T.; Wolf, M.A. Feb 1978.

Pacific Northwest Laboratory annual report for 1977 to the DOE Assistant Secretary for Environment. Part 3. Atmospheric sciences.

Thecretical calculations of the washout of cooling tower condensate droplets by frontal raindrops show that rainfall enhancement can be significant and is measurable under typical meteorological and cooling tower effluent source conditions. For the case of moderate rainfall rates and a wind speed of 5 m/sec, centerline rainfall enhancement was as much as 46%, cross-plume average enhancement as much as 7%, and distence to one-half depletion of the source 1 to 10 km.

199 (PNL--2500(Pt.3), pp 2.41-2.42) LABORATORY SIMULATIONS OF INTERACTIVE PLUMES FROM MECHANICAL DRAFT COOLING TOWERS. Kennberg, L.D. Feb 1978.

Pacific Northwest Laboratory annual report for 1977 to the DOE Assistant Secretary for Environment. Part 3. Atmospheric sciences.

In connection with studies being conducted under the Meteorological Effects of Thermal Energy Releases (METER) Program, Pacific Northwest Laboratory (PNL) has been simulating discharges from physical models of mechanical draft cooling towers to determine the impact of various conditions in cooling tower plume mixing and trajectory. Analysis of the data suggests that siting cooling towers should be based on ambient wind history, plume dynamics, and tower operating conditions, and possibly on site terrain.

200 (PNL--2500(Pt.3), pp 2.42-2.43) FIRE ANALOG: A COMPARISON BETWEEN FIRE PLUMES AND ENERGY CENTER COOLING TOWER PLUMES. Orgill, M.M. Feb 1978.

Pacific Northwest Laboratory annual report for 1977 to the DOE Assistant Secretary for Environment. Part 3. Atmospheric sciences.

Thermal plumes or convection columns associated with large fires have been compared to thermal plumes from cooling tower systems to evaluate the fire analog concept. Energy release rate of mass fires is generally larger than that of single or small groups of cooling towers but may be comparable to proposed large energy centers. However, siginficant physical differences exist between cooling tower and fire plumes. Cooling tower plumes are usually dominated by ambient wind and turbulence conditions. Fire plumes, depending on fire intensity and area, can transform into free convection energy systems resulting in convective columns, strong inflow and updrafts, turbulence and concentrated vortices. Since these characteristics have not been observed with cooling tower plumes to date, the fire analog concept is questionable at this time. Additional research is needed on fire and cooling tower plumes.

201 (PNL--2653-1) REACTOR SAFETY RESEARCH PROGRAMS. QUARTERLY REPORT, 1 JANUARY--31 MARCH 1978. Hooper, J.L. (Battelle Pacific Northwest Labs., Richland, WA (USA)). May 1978. Contract EY-76-C-06-1830. 135p. (NUREG/CR--0086). Dep. NTIS, PC A07/MF A01.

Progress is summarized in the following LWR safety-related studies: (1) ultimate heat sink performance measurements, (2) evaluation of atmospheric empirical diffusion data, (3) acoustic emission-flow relationship for in-service monitoring of pressure vessels, (4) steam generator tube integrity, (5) experimental verification of steady state codes, (6) core thermal model development, and (7) fuel subassembly procurement and irradiation test program. (DG)

202 (PNL--2661) COMPARATIVE COST STUDY OF FOUR WET/DRY COOLING CONCEPTS THAT USE AMMONIA AS THE INTERMEDIATE HEAT EXCHANGE FLUID. Tokarz, R.D.; Braun, D.J.; Johnson, B.M.; Allemann, R.T.; Braun, D.J.; Parry, H.L.; Smith, G.C.; Zaloudek, F.R. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Sep 1978. Contract EY-76-C-06-1830. 151p. Dep. NTIS, MF A01.

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The projected costs of five alternative wet/dry power plant heat rejection concepts were studied under conditions imposed by hypothetical use in association with the San Juan Unit 3 plant, a fossil-fuel 550-MWe facility currently under construction near the ''Four Corners'' area of New Mexico. Four of the cooling systems use ammonia as a heat transfer medium between the steam condenser and the heat rejection tower, while the fifth uses the condenser cooling water for heat transport. The four alternative concepts were: the HOTERV plate fin with deluge augmented cooling (vertical round towers); the HOTERV plate fin with deluge augmented cooling (horizontal configuration); the separate channel augmented tower (SCAT); a Curtiss-Wright extruded tube with integral fins, augmented with water flowing internally through separate channels, and the augmenting ammonia condenser (AAC); Curtiss-Wright tube augmented with a separate water-cooled condenser close-coupled to a conventional wet tower. The state-of-the-art method was the integrated wet/dry tower currently being constructed at the San Juan Unit 3 station. The comparable capital cost of each of the five concepts was calculated. Fuel savings resulting from using each of the advanced concepts vis-a-vis the reference integrated wet-dry cooling towers, expressed in barrels of oil per year, were calculated. The study indicates that the ammonia system with either the deluge scheme for wet/dry cooling, using the HOTERV plate fin heat exchange, or the Curtiss-Wright chipped-fin surface, (using either the SCAT arrangement or the separate water-cooled ammonia condenser for augmentation) are potentially more cost-effective than the state-of-the-art system for use in a power plant heat rejection system. This has been shown specifically only under conditions imposed by the site at the San Juan plant.

203 (PNL--2674(Vol.1)) USER'S MANUAL FOR THE BNW-II OPTIMIZATION CODE FOR DRY/WET-COOLED POWER PLANTS. Braun, D.J.; Bamberger, J.A.; Braun, D.J.; Faletti, D.W.; Wiles, L.E. (Battelle Pacific Northwest Labs., Richland, WA (USA)). May 1978. Contract EY-76-C-06-1830. 231p. Dep. NTIS, PC A11/MF A01.

The User's Manual describes how to operate BNW-II, a computer code developed by the Pacific Northwest Laboratory (PNL) as a part of its activities under the Department of Energy (DOE) Dry Cooling Enhancement Program. The computer program offers a comprehensive method of evaluating the cost savings potential of dry/wet-cooled heat rejection systems. Going beyond simple ''figure-of-merit'' cooling tower optimization, this method includes such items as the cost of annual replacement capacity, and the optimum split between plant scale-up and replacement capacity, as well as the purchase and operating costs of all major heat rejection

components. Hence the BNW-II code is a useful tool for determining potential cost savings of new dry/wet surfaces, new piping, or other components as part of an optimized system for a dry/wet-cooled plant.

204 (PNL--2715) CONCEPTUAL DESIGN STUDY ADVANCED CONCEPTS TEST (ACT) FACILITY. Zalcudek, F.R. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Sep 1978. Contract EY-76-C-06-1830. 126p. Dep. NTIS, PC A07/MF A01.

The Advanced Concepts Test (ACT) Project is part of program for developing improved power plant dry cooling systems in which ammonia is used as a heat transfer fluid between the power plant and the heat rejection tower. The test facility will be designed to condense 60,000 lb/hr of exhaust steam from the No. 1 turbine in the Kern Power Plant at Bakersfield, CA, transport the heat of condensation from the condenser to the cooling tower by an ammonia phase-change heat transport system, and dissipate this heat to the environs by a dry/wet deluge tower. The design and construction of the test facility will be the responsibility of the Electric Power Research Institute. The DOE, UCC/Linde, and the Pacific Northwest Laboratories will be involved in other phases of the project. The planned test facilities, its structures, mechanical and electrical equipment, control systems, codes and standards, decommissioning requirements, safety and environmental aspects, and energy impact are described. Six appendices of related information are included. (LCL)

205 (PNL--2745) ENGINEERING AND COST ANALYSIS OF A DRY COOLING SYSTEM AUGMENTED WITH A THERMAL STORAGE POND. Drost, M.K.; Allemann, R.T. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Sep 1978. Contract EY-76-C-06-1830. 93p. Dep. NTIS, PC A05/MF A01.

An engineering and cost study of the capacitive thermal storage pond added to a state-of-the-art dry cooling system is described. The purpose of the study was to assess the potential for reducing the cost of all-dry cooling for thermal electric power plants using a dry cooling system that includes a thermal storage pond. Using the modified BNW-I computer code, the effect of varying significant design parameters was investigated. The parametric study included studying the effects of varying turbine type, pond size, replacement energy costing, capacity penalty methodology, pond location with respect to the dry cooling tower, design temperature, and site location (meteorology). Incremental power production costs for dry cooling (i.e., the portion of the cost of bus-bar electricity from the plant which is attributable to the cost of building and operating the heat rejection system) with a thermal storage pond system were determined for meteorologies of both Wyodak, Wyoming and Phoenix, Arizona. For Wyodak the incremental cost of dry cooling with a thermal storage pond was 2.81 mills/kWh as compared to 2.55 mills/kWh for a system without a thermal storage pond. For Phoenix the incremental cost of dry cooling with a thermal storage pond was 3.66 mills/kWh as compared to 4.31 mills/kWh for a system without a thermal storage pond. If the use of a modified conventional turbine with the dry-cooled system is stipulated in order to stay with proven technology for large turbines, then results of this study show that in extremely hot climates the thermal storage pond can reduce the cost of dry cooling. If no cost penalty is assigned to high back pressure turbines and it can be used, then the thermal storage pond has no advantage in hot climates. However, collateral use of the pond for makeup or emergency cooling water storage may decrease the cost. (LCL)

206 (PNL--2850(Pt.3), pp 2.26-2.29) COOLING TOWER DRIFT: COMPREHENSIVE CASE STUDY. Laulainen, N.S.; Ulanski, S.L. Feb 1979.

Pacific Northwest Laboratory annual report for 1978 to the DOE Assistant Secretary for Environment. Part 3. Atmospheric sciences.

A comprehensive experiment to study drift from mechanical drift cooling towers was conducted during June 1978 at the PG and E Pittsburg Power Plant. The data from this study will be used for validation of drift deposition models. Preliminary results show the effects of tower geometry and orientation with respect to the wind and to single- or two-tower operation. The effect of decreasing relative humidity during a test run can also be seen.

207 (PNL--2850(Pt.3)) PACIFIC NORTHWEST LABORATORY ANNUAL REPORT FOR 1978 TO THE DOE ASSISTANT SECRETARY FOR ENVIRONMENT. PART 3. ATMOSPHERIC SCIENCES. Simpson, C.L. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Feb 1979. Contract EY-76-C-06-1830. 116p. Dep. NTIS, PC A06/MF A01.

Separate abstracts were prepared for the 39 papers presented in the report. An author index and lists of publications and presentations are also included. (HLW)

208 (PNL--2850(Pt.5), pp 2.0-2.52) ENVIRONMENTAL CONTROL ENGINEERING. Feb 1979.

Pacific Northwest Laboratory annual report for 1978 to the DOE Assistant Secretary for Environment. Part 5. Environmental assessment, control, health and safety.

Progress is reported on the following projects: assessment of environmental technology for coal gas separation; energy material transport, 1977 to 2000; dry/wet cooling towers; liquefied natural gas safety and control; burning of oil spills; liquified petroleum (LPG) research assessment; treatment of oil shale; geothermal liquid waste disposal; compressed air energy storage; energy-conserving industrial waste treatment; analysis of nuclear fuel cycles; transportation safety study; decommissioning of retired facilities at Hanford: planning; characterization of Hanford 300 Area burial grounds; decontamination and decommissioning of Hanford facilities: technology; assistance for nationwide decommissioning planning for DOE nuclear facilities; and, asphalt emulsion sealing of uranium tailings. (JGB)

209 (PNL--2931) BIOCIDE BY-PRODUCTS IN AQUATIC ENVIRONMENTS. QUARTERLY PROGRESS REPORT, OCTOBER 1--DECEMBER 31, 1978. Anderson, D.R.; Bean, R.M.; Gibson, C.I. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Mar 1979. Contract EY-76-C-06-1830. 45p. Dep. NTIS, PC A03/MF A01.

Analysis of water samples from several locations across the U.S. is underway. We have completed analysis using the Purge and Trap and headspace techniques on several locations. In the freshwater phase of the program we have completed fifteen chloroform acute toxicity bioassays with rainbow trout (Salmo gairdneri), bluegill (Lepomis macrochirus), and catfish (Ictalurus punctatus). Results indicate, in all cases, the LC-50 is well above that which could be expected to be discharged due to power plant chlorination. The LC-50's range from about 15 to 50 ppm chloroform depending on the species.

Histological analysis is underway on clams from long-term chlorination by-product exposures. If the results of the histological analysis indicate an effect, further histological examination of samples from other concentrations will be conducted.

210 (PNL--2988) BIOCIDE BY-PRODUCTS IN AQUATIC ENVIRONMENTS. QUARTERLY PROGRESS REPORT, JANUARY 1--MARCH 31, 1979. Anderson, D.R.; Bean, R.M.; Gibson, C.I.; Reed, P.R. (Battelle Pacific Northwest Labs., Richland, WA (USA)). May 1979. Contract EY-76-C-06-1830. 55p. Dep. NTIS, PC A04/MF A01.

Results of organohalogen analysis of samples collected from marine and freshwater locations in the continental United States are presented. Analysis of ether extracts of these samples for the four major halogens, and for total organic halogen has shown that while halogenated component concentrations can vary widely from station to station, the bulk of the organic halogen is in the form of haloform. Chromatography of the extracts has shown the halogenated material to be less than 800 molecular weight. In the fresh water studies, chloroform was shown to be less toxic to largemouth bass (96 hr LC_{50} of 45-56 ppM), than rainbow trout (15-22 ppM), or bluegill (13 to 22 ppM). These levels are about three orders of magnitude higher than concentrations of haloform found in the chlorinated water sampling apparatus. Preliminary analysis of tissues from chloroform-exposed catfish indicate that this compound is concentrated in the fatty tissues and gut to levels of about an order of magnitude higher than the surrounding water. Analyses of tissues from the eastern oyster, quahaug clam, littleneck clam, menhaden, and shrimp exposed to bromoform over a 28-day period, have shown that bromoform uptake is rapid, with at least some bioconcentration observed in most cases. Depuration was also rapid, taking place within 48 hrs after termination of exposure. Specimens of littleneck clams whichwere exposed to seawater treated with up to 100 ppB chlorine have been studied with respect to growth and histology. It was found that this clam adapts poorly to being held in aquaria as evidenced by lack of growth for the first five months of the study and by the generally poor condition of their tissues during the initial phases. Clams exposed to less than 12 ppB chlorine were observed to recover. However, at higher concentrations, tissue damage was evident after six months and no growth was observed after eight months. (ERB)

211 (RFP--2877) CHEMISTRY RESEARCH AND DEVELOPMENT. PROGRESS REPORT, JUNE--NOVEMBER 1978. Miner, F.J. (Rockwell International Corp., Golden, CO (USA). Rocky Flats Plant). 28 May 1979. Contract EY-76-C-04-3533. 64p. Dep. NTIS, PC A04/MF A01.

Activities and progress are reported in the following areas: component development, pilot plant development, and instrumentation and statistical systems. (DLC)

212 (SERI/TP--53-114R) REVIEW OF THE ENVIRONMENTAL EFFECTS AND BENEFITS OF SELECTED SOLAR ENERGY TECHNOLOGIES. Lawrence, K.A. (Solar Energy Research Inst., Golden, CO (USA)). May 1979. Contract EG-77-C-01-4042. 18p. Dep. NTIS, PC A02/MF A01.

Data are reviewed and summarized on the environmental effects of three solar energy technologies: photovoltaic cells, wind energy conversion (WEC), and the solar thermal central receiver. Potential effects are identified for each of the life cycle phases: resource extraction and component manufacture, plant construction, operation and decommission. The solar energy technologies are assumed to be deployed as centralized energy production facilities. The technologies examined are materials intensive compared to fossil fuel plants with the same power rating. As a result, the life-cycle phase of resource extraction and component production is the most environmentally hazardous. Impacts of plant construction will be somewhat site specific but should approximate impacts associated with any large construction activity. The operation phase is relatively environmentally benign. WEC operation does produce low-level noise pollution and presents minimal hazards to flying species. Solar thermal facilities equipped with wet cooling towers may affect local air quality via cooling tower drift. In addition, large installations of each option may alter local microclimate. Decommission of WEC, solar thermal, and Si-photovoltaic facilities should present no environmental hazards, although disposal of CdS or GaAs cells will require care.

213 (SOLAR/2004--79/50) SOLAR PROJECT DESCRIPTION FOR TRINITY UNIVERSITY POWER PLANT NO. 2. Hale, H.J. (PRC Energy Analysis Co., McLean, VA (USA)). 8 Sep 1978. Contract EG-77-C-01-2522. 56p. Dep. NTIS, PC A04/MF A01.

This solar system in San Antonio, Texas is used for space heating, cooling, and hot water for six 500-student dormitories and an athletic complex for a total floor space of about 285,000 ft^2. The overall concentrating collector area is about 16,080 ft^2. Two 20,000 storage tanks are used for thermal storage. A solar-power 352 ton absorption chiller is used for space cooling. A three-cell ceramic cooling tower rejects heat from the condenser water. The auxiliary energy system consists of a 405 hp natural gas boiler, a 623 ton electric centrifugal chiller, and the cooling tower. The solar energy system has been fully instrumented for thermal performance and integrated into the National Solar Data network. The system has been operational since June 1977. (MHR)

214 (STU--76-3279) LABORATORY TESTING OF CORROSION INHIBITORS FOR RECIRCULATING COOLING WATER SYSTEMS. Khullar, M.; Pattyranie, C. (Styrelsen foer Teknisk Utveckling, Stockholm (Sweden)). Oct 1978. 18p. (In Swedish). Dep. NTIS (US Sales Only), PC A02/MF A01.

Cooling water corrosion inhibitors used in Sweden are to a great extent imported from other countries such as Great Britain, Germany and the U.S.A. These inhibitors have been formulated as a result of experience gained in their respective countries and according to their own water qualities. The performance of these inhibitors in Swedish waters and under the working conditions here could hardly be considered trouble free. Therefore, evaluation of cooling water treatment effectiveness can offer significant savings to the industry. The program for evaluating corrosion inhibitors was started about two years ago. The aims of this study were to: investigate different laboratory methods for testing corrosion inhibitors; verify previous findings under cooling water conditions normally found in Scandinavian countries; evaluate some molybdate based inhibitors; and develop economical nontoxic formulations for use in recirculating cooling water systems. In this investigation a testing method (a rotor test) was constructed. This test has proved to be a useful and reliable weight loss determination method. Some

inhibitors used for the rotor test method were also tried in pilot plant units. The performance of inhibitors tested in the pilot plant fall in the same order of effectiveness as shown in the results of the rotor test method, but, as expected, weight loss values are much lower as compared with the rotor test method.

215 (TID--3360(Suppl.3)) COOLING TOWERS. BIBLIOGRAPHY, JANUARY--DECEMBER 1978. Galde, D.O. (Department of Energy, Oak Ridge, TN (USA). Technical Information Center). Feb 1979. 102p. Dep. NTIS, PC A06/MF A01.
Included are 382 citations to references on cooling towers for fossil-fuel or nuclear power plants. A few citations are included on other types of condenser cooling systems, e.g., cooling ponds and canals. The citations were taken from the DOE Energy Information Data Base (EDB) covering the period January 1978 through December 1978. Corporate, Personal Author, Subject, and Report Number Indexes are provided.

216 (TID--29084) SAFETY CONSIDERATIONS REPORT: MONTANA COMPONENT DEVELOPMENT AND INTEGRATION FACILITY (CDIF). (Gilbert/ Commonwealth, Reading, PA (USA)). 26 Jan 1976. Contract EX-76-C-01-1236. 119p. Dep. NTIS, PC A06/MF A01.
The current efforts of attempting to identify the required safety considerations for the CIIF coal-fired MHD generator are presented. Major hazards encounteded include (1) primary explosions in processing equipment followed by secondary explosions in buildings due to turbulent dust suspensions resulting from the primary explosion; (2) rupture of combustor at 150 psi at 4800 F; (3) coal dust spread from pipe rupture exploding in building; and (4) rupturing of an air heater vessel or piping at 150 psi at 3000 F. Such (potential) explosions or ruptures can create shock waves that knock down building walls, and the sudden rupture of vessels can also send projectiles flying at high speeds. Coal dust explosions have caused extensive damage. They may be less violent than some gas explosions unless the coal is volatilized by heat and/or gases are also present. In this system, the coal will move from crushed to pulverized to plasma. Among other major hazards are the high voltage in the combustor-channel portions (3,000 - 20,000 volts) presenting electric shock and arcing problems.

217 (TREE--1365) ANALYSIS OF BINARY THERMODYNAMIC CYCLES FOR A MODERATELY LOW-TEMPERATURE GEOTHERMAL RESOURCE. Demuth, O.J. (Idaho National Engineering Lab., Idaho Falls (USA)). Jul 1979. Contract EY-76-C-07-1570. 105p. Dep. NTIS, PC A06/MF A01.
Analyses of a number of geothermal binary-cycles were made with the objective of finding a cycle which can produce low-cost electrical energy from a moderately low-temperature geothermal resource. Cycles were screened which included isobutane, pentane, cis-2-butene, and several mixed-hydrocarbon working fluids. Dual- and triple-boiling cycles were analyzed. Both shell-and-tube and direct-contact boilers, heaters, and condensers were assessed. A geothermal fluid (geo-fluid), typical of Raft River resource conditions was assumed, which has a temperature of 290°F and 52 parts per million dissolved nitrogen. Special emphasis in the analyses was directed toward investigation of several methods for keeping the loss of working fluid for the cycle at an acceptable level. It was concluded that for the Raft River geo-fluid, the direct-contact cycle has a potential for net geofluid utilization effectiveness values, (watt-hr/lbm geo-fluid) equivalent to those of the shell-and-tube cycle. Therefore, because of the lower cost of direct-contact components, a potential exists for the direct-contact plant to produce lower cost electrical energy than a comparable shell-and-tube plant. Advanced cycles were assessed which showed improvements in net geo-fluid utilization effectivness, relative to the first Raft River 5-MW Pilot Plant (dual-boiling, shell-and-tube isobutane cycle), of up to 19%.

218 (UCID--18155-79-1) GEOTHERMAL ENVIRONMENTAL CONTROL TECHNOLOGY. PROGRESS REPORT, DECEMBER 1978--MARCH 1979. Phelps, P.; Hill, J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Apr 1979. Contract W-7405-ENG-48. 141p. Dep. NTIS, PC A07/MF A01.
The following items are included: outline for report on ECT (Environmental Control Technology) workshop for The Geysers - Calistoga KGRA; outline for report on ECT for the Imperial Valley; a list of documents reviewed; an update on the Geothermal Loan Guaranty Program; trip reports; an update on LLL work to reabsorb H_2S in spent brine done at Niland; meeting summaries; field task proposal; a summary of a joint cooling tower effects study; and a fiscal and manpower statement. (MHR)

219 (UCRL--15054) GEYSERS-CALISTOGA KGRA GEOTHERMAL ENVIRONMENTAL OVERVIEW: WATER QUALITY. Moore, S.F.; Pimentel, K.D.; Krone, R.B. (Resource Management Associates, Lafayette, CA (USA); California Univ., Livermore (USA). Lawrence Livermore Lab.; California Univ., Davis (USA)). Feb 1978. Contract W-7405-ENG-48. 79p. Dep. NTIS, PC A05/MF A01.
Important water-related issues of concern are identified and the available information regarding potential impacts on the quantity and quality of water in an area is assessed. The results of a study and a two-day workshop that included representatives of developers and of concerned local, state, and federal agencies are presented. An inventory of existing data is included in an appendix. (MHR)

220 (UCRL--52496(Vol.5)) ENVIRONMENTAL OVERVIEW OF GEOTHERMAL DEVELOPMENT: THE GEYSERS--CALITOGA KGRA. VOLUME 5. ECOSYSTEM QUALITY. Leitner, P. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 13 Sep 1978. Contract W-7405-ENG-48. 60p. Dep. NTIS, PC A04/MF A01.
Objectives of the Geothermal Overview Project for this KGRA were identification of ecosystem issues, evaluation of the existing data base, and recommendation of additional research needed to resolve key issues. The issue of highest priority is the lack of complete and accurate data on the status and distribution of rare or endangered plants and animals within the KGRA. Several studies are recommended to provide adequate information: a KGRA-wide effort to identify rare plants and their habitats, a site-specific determination of peregrine falcon foraging habitat, and a compilation of available data on other wildlife species of special concern. Medium-priority issues include the possible impacts of hydrogen sulfide emissions on vineyard and orchard crops and the ecological effects of boron and heavy metals released from geothermal power plants in cooling tower drift. The potential for adverse effects is uncertain and research should be

initiated promptly to determine whether these effluents pose serious problems. A third medium-priority issue concerns the potential for long-term cumulative impacts of geothermal development on natural ecosystems. To detect and evaluate such effects, it will be necessary to carry out additional baseline studies of terrestrial and aquatic ecosystems and to follow this with carefully designed monitoring programs. Several issues were given low priority in planning for additional research needs. For example, further studies of the biological effects of accidental spills of steam condensate and other potentially hazardous wastes are not recommended at this time; emphasis should be placed on spill prevention. Geothermal noise effects on wildlife have been studied within the KGRA; because of methodological problems, additional work would probably not be productive. Water vapor and aerosol emissions from cooling towers may affect agricultural operations by increasing the frequency of fogging and icing conditions.

221 (UCRL--52496(Vol.6)) ENVIRONMENTAL OVERVIEW OF GEOTHERMAL DEVELOPMENT: THE GEYSERS-CALISTOGA KGRA. VOLUME 6. WATER QUALITY. Pimentel, K.D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1? Oct 1978. Contract W-7405-ENG-48. 54p. Dep. NTIS, PC A04/MF A01.

This report identifies key issues, assesses available information, and recommends research related to water quality degradation resulting from geothermal development in The Geysers-Calistoga Known Geothermal Resource Area. Data necessary for making decisions to minimize damage while allowing development is lacking in three areas: For the whole KGRA, there is insufficient information on the relation of industry-related construction to erosion, with its resulting increase in sediment and silt in area streams. The effects of cooling tower drift on soils and vegetation near power plants should be studied as precursors of potential effects on water quality. For the hot-water resource area in the eastern portion of the KGRA, a long-range program of water quality monitoring is needed to establish a baseline.

222 METHOD OF CALCULATION OF DYNAMICS AND THERMICS OF COOLING RESERVOIRS. Raspopin, G.A.; Kovalev, E.A.; Voronkov, G.V. (Novosibirsk Eng Constr Inst, USSR). Izv. Vyssh. Uchebn. Zaved., Energ.; No. 11, 106-113(Nov 1979). (In Russian).

Some specific features of currents and distribution of temperatures in cooling reservoirs are noted. A mathematical model of calculation of the dynamics and thermics of cooling reservoirs is presented taking account of the temperature stratification of the reservoir and the driving layer of the atmosphere. In this conjunction, Fourier-Kirchhof equations of motion and distribution of heat are used. Calculation in accordance with the proposed method is possible on a BESM-6-type computer.

223 HOW TO CONTROL BIO-SLIME IN CONDENSER COOLING SYSTEM WATER. Freymark, S. Electr. Light Power (Boston); 57: No. 8, 33-34(Aug 1979).

A number of oxidizing and non-oxidizing biocides are currently used for biocontrol. However, yesterday's solution to slime-fouling problems may not apply today in view of tightening effluent restrictions on chlorine. Thus, selection of biocontrol compounds can not be made indiscriminately. In selecting alternative biocontrol compounds, consideration should be given not only to costs but to effectiveness of the biocide in each particular application, taking into consideration cooling water quality, type of microbiological fouling and discharge restrictions. Thoughtful selection of the biocontrol compound(s), alone or in combination with surface-active agents, is essential for maintaining maximum microbiological control in condenser cooling water systems.

224 HEAT TRANSFER THROUGH THE THERMAL SKIN OF A COOLING POND WITH WAVES. Wesely, M.L. (Atmospheric Physics Section, Radiological and Environmental Research Division, Argonne National Laboratory, Argonne, Illinois 60439). J. Geophys. Res.; 84: No. C7, 3696-3700(20 Jul 1979).

The temperature drop measured across the cool skin of a cooling pond is examined for 64 10-min data collection periods taken with wind speeds of 3--8.5 m s^{-1} (effectively at a height of 10 m) and surface temperatures of 18°-37.5°C. The total heat transfer through the skin is found with the use of bulk aerodynamic estimates of the latent and sensible heat flux densities and empirical expressions for the long-wave radiation exchange at the surface. Although it is questionable to describe the characteristics of a surface with waves by use of formulae derived partially on the assumption that a rigid boundary exists at the air-water interface, the parameterizations that result seem on the average to perform quite well. For example, values of the numerical proportionally coefficient lambda [Saunders, 1967], which relates the total heat transfer to the temperature drop, increase slightly from 6 to 7 as water temperature increases; these values are near those reported previously. No variation of lambda with wind speed is detected. If lambda is replaced by a numerical coefficient that also takes into account the difference of the thicknesses of the thermal and viscous sublayers, the new coefficient Aapprox. =lambdaPr/sup 1/3/, where Pr is the Prandtl number, does not vary significantly with temperature of the surface skin.

225 CONTROL OF FOULING ORGANISMS IN ESTUARINE COOLING WATER SYSTEMS BY CHLORINE AND BROMINE CHLORIDE. Burton, D.T.; Margrey, S.L. (Acad of Nat Sci of Philadelphia, Benedict, Md). Environ. Sci. Technol.; 13: No. 6, 684-689(Jun 1979).

The study described was initiated to evaluate the antifouling effectiveness of chlorine and bromine chloride in low velocity flow areas where estuarine waters are used for cooling purposes. The relative antifouling effectiveness of chlorine and bromine chloride under intermittent and continuous modes of application in low velocity flow areas was evaluated at an estuarine power plant located on the Chesapeake Bay.

226 AEROSOL AND ICE NUCLEI MEASUREMENTS IN THE PLUME OF THE HOMER CITY, PA., POWER PLANT. Pueschel, R.F.; Schnell, R.C.; Weickmann, H.K.; Wellman, D.L. (NOAA, ERL, Atmospheric Physics and Chemistry Laboratory, Boulder, CO 80303). Geophys. Res. Lett.; 6: No. 5, 371-374(May 1979).

The power plant produces aerosols that, in a clean atmosphere, enhance the concentration of particles of sizes smaller than 0.1 μm by more than two orders of magnitude, and of sizes larger than 1.0 μm by about a factor of ten. After two days of stagnant atmospheric conditions, ambient aerosol concentrations

reach plume proportions. The plume-related aerosol has no effect on the threshold temperature of the freezing of supercooled water.

227 MANAGING WASTE HEAT WITH THE WATER COOLING TOWER. Dickey, J.B. Jr. (Marley Cool Tower Cc). Combustion; 50: No. 11, 12-19(May 1979).

Evaluations and optimizing procedures for power plant condensing cycles incorporating various cooling tower modes are explained. Actual mechanical draft installations are tabulated with thermal conditions versus costs. A commercial rating and selection system is presented in graphics for mechanical draft and natural draft wet towers. Nomograms yield effluent quantities and effluent wet bulb condition for complete ranges of towers used in power plants. Current application trends are also examined.

228 (ANL-Trans--1163) PROGRAMS FOG1PLT AND FOG2PLT FOR PLOTTING COOLING TOWER PLUMES CALCULATED BY THE FOG1 PROGRAM. Rudin, F. (Eidgenoessisches Inst. fuer Reaktorforschung, Wuerenlingen (Switzerland)). Apr 1979. Translation of pp 1-14 and 25, TM-ST--564 29p. Dep. NTIS, PC A03/MF A01.

FOG1PLT is an expansion of the FOG1 program and serves for plotting a vertical longitudinal section of the moisture field of the calculated cooling tower plume. Selected isolines of the moisture elevation are plotted and condensation zones are identified by dot-shading. FOG2PLT is also an expansion of FOG1 and allows a superposition of the plumes of up to five cooling towers located at great distances from each other (1 to several km) and to present the results graphically in the same way as with FOG1PLT. Up until now, cases with up to four cooling towers were computed with spacings of 2 to 30 km between two conseecutive towers and a total distance of 60 km for plume diffusion. The results obtained under these conditions were physically plausible.

229 COOLING TOWER EFFICIENCY MORE THAN DOUBLED. Erandesky, R.; English, K. (Sun Petroleum Products Co., Corpus Christi, TX). Chem. Process. (Chicago); 42: No. 4, 30(Apr 1979).

The modifications made to an industrial cooling tower, including an improved heat distribution system with PVC block media and a fan with fiberglass-reinforced epoxy resin blades, are described. These modifications resulted in more than doubling the operating efficiency of the cooling tower. The system has operated for more than a year with no maintenance problems. (LCL)

230 AIR RADIATOR COOLING TOWER. Kazanovich, B.B.; Santurian, G.R.; Fischenko, P.A. US Patent 4,142,579. 6 Mar 1979. Filed date 16 May 1977. 8p.

The invention discloses an air radiator cooling tower comprising a piping system for the supply and removal of water circulating in cooled tubular elements joined into groups by means of tubular girders, an exhaust tower for the circulation of cooling air, and a device for the excitation of oscillations transmitted through direct contact over the surface of the tubular elements and/or the water being cooled. The proposed air radiator cooling tower may be employed in power engineering for cooling condensers at steam power stations.

231 STUDY OF COOLING POND FOG GENERATION. Leahey, D.M. (Western Research and Development, Calgary, Alberta); Davies, M.J.E.; Panek, L.A. J. Air Pollut. Control Assoc.; 29: No. 3, 257-259(Mar 1979).

From mid January to the first of April 1977 Western Research and Development conducted studies into the frequency, extent, and density of fog resulting from the 1200 acre cooling pond which services Calgary Power Ltd.'s Sundance Thermal Power Station. This station is located in the western part of central Alberta. The rectangular cooling pond fog model showed appreciable skill in predicting diurnal changes in fog frequency as well as the occurrences of fog episodes. It seems to present a realistic general description of fog behavior. Results of fog model verifications illustrate the importance of vertical atmospheric potential temperature gradients and sensible heat fluxes to the formation of cooling pond fog. Stable atmospheres associated with positive potential temperature gradients restrict the fog to layers near the ground. Release of sensible heat from the pond helps to determine the depth of these layers and hence the fog density. The model was not as successful in predicting the details of fog occurrence as denoted by hourly observations. This appears to be due mainly to uncertainties in model parameters such as evaporation and moisture deficit. This rote has concerned the use of the fog model to predict fog occurrences. The model may also be used to predict the downwind extent of cooling pond fog. This aspect of the model has yet to be evaluated.

232 KNOW YOUR COOLING TOWER. Burger, R. (Robert Burger Assoc, New York, NY). Power (N.Y.); 123: No. 3, 42-44(Mar 1979).

The basic principles of operation of mechanical-draft and forced-draft towers and of the counterflow and crossflow towers are explained. Various subsystems are briefly described, in particular: the air moving equipment, the draft-elimination system, the wet-decking surfaces, the water-distribution system, the structural members or framework.

233 PRECIPITATION AS ATMOSPHERIC DISTURBANCE IN THE OPERATION OF NATURAL-DRAUGHT DRY COOLING TOWERS. Herberholz, P.; Schulz, S. Brennst.-Waerme-Kraft; 31: No. 3, 100-102(Mar 1979). (In German).

As a contribution in the field of atmospheric disturbing influences on dry cooling towers, a method is presented which allows the changes of the effective temperature range of a dry cooling tower due to precipitation to be calculated, and thus the change of its cooling effect. Initial information on cooling towers and meteorology are used as a basis. The article is intended mainly for the subjects of acceptance, design and systematic parameter research on natural-draught dry cooling towers.

234 PIPELINE FROM SEWAGE PLANT FILLS A-PLANT'S COOLING NEEDS. Eng. News-Rec.; 202: No. 5, 20-21(1 Feb 1979).

Primary treated effluent from a Phoenix sewage plant will be sent by pipeline to the Palo Verde nuclear plant to be used as coolant. Prestressed concrete cylindrical pipe will be used. Fabrication and installation of the pipeline are described. (FS)

235 POTENTIAL WEATHER MODIFICATION CAUSED BY WASTE HEAT RELEASE FROM LARGE DRY COOLING TOWERS. Lee, J. (Assistant Environmental

Scientist, Energy and Environmental Systems Division, Argonne National Laboratory, Argonne, Ill. 60439). J. Heat Transfer; 101: No. 1, 164-168(Feb 1979).

A numerical model of a cooling tower plume is employed to study the possible atmospheric effects of thermal plumes from natural draft dry cooling towers. Calculations are performed for both single and multiple towers, each of which can dissipate the waste heat from a nominal 1000 MWe power generating unit, and the results are compared with those for wet cooling towers associated with plants of the same generating capacity. Dry cooling tower plumes are found to have a higher potential for inducing convective clouds than wet cooling tower plumes, under most summertime meteorological conditions. This is due to the fact that both the sensible heat and momentum fluxes from a dry tower in summer are approximately one order of magnitude larger than those from a wet cooling tower.

236 MICROPROCESSORS CONTROL CHEMICAL ADDITION AND COKING UNIT COOLING. Mitchell, J.W. (Amoco Tex Refin Co, Texas City). Hydrocarbon Process.; 58: No. 2, 137-140(Feb 1979).

This paper outlines some guidelines for evaluating microprocessor systems for control applications, and examples of microprocessors applied to add chemicals to cooling water and to automate the cool down cycle of a coking unit. The two microprocessor systems are among several monitoring and controlling systems which have been developed and installed at Amoco's Texas City refinery. By the end of 1978 there will be 12-14 microprocessor applications at the refinery. Microprocessors will undoubtedly continue to be used on small and medium-sized applications.

237 DEVELOPMENT OF NUCLEAR ENERGY IN WEST GERMANY. Schulten, R. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorentwicklung). Schweissen Schneiden; 31: No. 2, 60-64(Feb 1979). (In German).

For a long time to come, nuclear energy will be the main source of energy for many western nations, and also for west Germany. Planning and future decisions in this field must therefore be considered under the aspect of long-term effects. High temperature reactors will be suppliers of energy and can be employed to produce electricity and heat. New problems like dry cooling and the gasification of coal are capable of being solved. Moreover, high temperature reactors offer themselves for a number of applications in the production of gaseous and liquid fuels in the more distant future, and they can make a significant contribution towards solving the problem of optimal utilization of fuels.

238 CHEMICALS COMBAT CORROSION AT INDIANA PLANT. Public Power; 37: No. 1, 24, 26(Jan 1979).

A new environmentally acceptable corrosion inhibitor that allows a Richmond, Indiana power station to operate a cooling system with a wide fluctuation in water hardness and suspended solids replaces a chromate-based inhibitor in use for over 20 years. The new system uses the multi-functional organic corrosion inhibitor and sequesterant PolyMate 928 and the synthetic organic anti-foulant Dearborn 726, a combination which was selected after extensive testing. The corrosion inhibitor uses no toxic chromate or other heavy metals. Dearcide 713 and 717 are used alternately to prevent microbiological fouling. The microbiocides and antifoulant keep the system clean so that the corrosion inhibitor can deposit a continuous film on the wet surfaces.

239 (ANL-Trans--1160) FLIGHT MEASUREMENTS ON COOLING TOWER PLUMES: MEASUREMENT DATA FROM THE NEURATH II MEASUREMENT PROGRAM ON WET NATURAL DRAFT COOLING TOWERS. Trepp, J.P. (Eidgenoessisches Inst. fuer Reaktorforschung, Wuerenlingen (Switzerland)). Jan 1979. Translation of Report TM-ST--509 224p. Dep. NTIS, PC A10/MF A01.

The present report is to be considered a supplement to the EIR report ''Results of Measurements on Cooling Tower Plumes'' , to the extent that this report represents the foundation for the evaluation of the flight measurements and is an indispensable reference work for correct understanding of the results. This report contains the raw data measured with the power glider ASK-16 during a measurement program in Neurath (FRG) on wet natural draft cooling towers, and contains the results of processing of this data, which pertains to temperature, moisture, and turbulence. The measurement values are given in their complete extent and in detail, in the form of graphs; they are also described briefly, along with a description of the processing method.

240 CLOSE STUDY OF COOLING-TOWER PUMP INTAKES ADDS TO RELIABILITY OVER PERFORMANCE RANGE. Dicmas, J.L.; Fornesi, R. (Johnston Pump Co). Power (N.Y.); 123: No. 1, 94-96(Jan 1979).

The article considers: suction-intake design, suction-bell submergence, air-entrainment potential, and net positive suction head of cooling towers. Tips are given on possible problems and ways to assure reliable operation of cooling towers.

241 VGB-Richtlinien zum Anfragen und Bestellen von Kuehltuermen. (VGB GUIDELINES FOR INQUIRIES AND ORDERS OF COOLING TOWERS). Essen, Germany, F.R.; VGB-Kraftwerkstechnik (1979). 112p. (In German).

The present 'VGB guidelines for inquiries and orders of cooling towers' are a common basis for the handling of requests and orders for all kinds of cooling towers. This will help to standardize technical, economic, and competitive conditions for comparable offers and to facilitate cooperation between all parties concerned.

242 REVIEW OF POTENTIAL BIOLOGICAL IMPACTS OF COOLING TOWER SALT DRIFT. Talbot, J.J. Atmos. Environ.; 13: No. 3, 395-405(1979).

Salt drift generated by the operation of closed-cycle cooling systems from electric power generating stations is reviewed. Emphasis is placed on the interpretation of experimentally determined salt impacts extrapolated to theoretical predictions of salt concentrations from cooling towers, since there are, at the most, two or three closed-cycle cooling systems where potential impacts have been addressed. Threshold concentrations at which various floral species would be harmfully affected by drift deposition and distances from the cooling tower at which these levels are attained or exceeded are discussed.

243 (ANL-Trans--1157) PLUME SIMULATION MODEL FOG DESCRIPTION OF THE PROGRAM AND INPUT. Gassman, F. (Eidgenoessisches Inst. fuer Reaktorforschung, Wuerenlingen (Switzerland)). Dec 1978. Translation of TM-ST--563, November 8, 1978 27p. Dep. NTIS, PC A03/MF A01.

The mathematical plume simulation model FOG

is suitable for the calculation of plumes with or without lift, emitted by cooling towers of any given construction or by chimneys, into the atmosphere boundary layer. The program was developed, starting in 1973, at the request of the Confederation Office for Energy Economy (Waste Heat Commission, Cooling Tower Commission) and later in the framework of the HHT project (Microclimate Project). Since then, it has been used for diverse studies on the influencing of the environment by cooling tower plumes and is presently used in the project CLIMOD (Climate Study for the Rhine Valley between Basel and Koblenz) for prediction of plume lengths in weather conditions which are especially critical in this connection. The version of FOG described here is the basic version FOG 1. The versions FOG1PLT for creating the moisture isoline figures and FOG2PLT for calculations of superimpositions, are described in TM-ST-564. Sections 2 and 3 of the present technical report thus are part of the EIR Report No. 347.

244 (ANL-Trans--1154) DESCRIPTION OF THE MODEL SMOKA FOR CALCULATING COOLING TOWER EMISSIONS AND THEIR EFFECTS. Rudolf, B. Dec 1978. Translation source information not available 15p. Dep. NTIS, PC A02/MF A01.

SMOKA (simulation model for cooling tower effects) is a thermodynamic, one-dimensional, steady-state numerical model for calculating the propagation of heat and water in the atmosphere above cooling towers. The fields of the magnitudes describing the atmospheric conditions are changed by the cooling tower emissions, including the visible plume, and these changes can be represented three-dimensionally in their spatial position. SMOKA is thus a quasi-three-dimensional model. Calculations can be performed for groups with several (also varying) sources (cooling towers/chimneys). As a subprogram for calculating the condition of the air at the outlet of the source, there are presently available: NASS for natural draft wet cooling towers, TROCKEN for natural draft dry cooling towers, and HYBRID for ventilator hybrid cooling towers. These subprograms have to be adapted according to the scope of the data supplied by the cooling tower manufacturer. This source data can also be input directly when it is known. In addition, the condition of the undisturbed atmosphere (basic condition) must be given. This must be horizontally homogeneous, but any random vertical stratification is permitted. (The present program version provides for the input of data for height or air pressure, air temperature, dew point, or relative humidity, and wind direction and velocity.)

245 DEFORMATION AND STABILITY OF WIND LOADED HYPERBOLIC COOLING TOWER SHELLS. Mang, H.; Torcicky, P. (Technische Univ., Vienna (Austria). Inst. fuer Elastizitaet- und Festigkeitslehre); Gallagher, R.H. (Arizona Univ., Tucson (USA). Coll. of Engineering); Cedolin, L. (Politecnico di Milano (Italy). Istituto di Scienza e Tecnica delle Costruzioni). Ing.-Arch.; 47: No. 6, 391-410(Dec 1978). (In German).

Following the formulation of the deformation and stability problem on the basis of originally non-conforming triangular curved finite elements with the help of a variational principle with subsidiary conditions, the deformation problem is solved numerically for an existing cooling tower shell. The subsequent stability analysis of this cooling tower shell shows relatively good agreement of the buckling safety computed by means of the finite element method and the minimum of buckling safety obtained with the help of Mungan's stability criterion.

246 MEASUREMENTS AND VEGETATIONAL IMPACT OF CHEMICAL DRIFT FROM MECHANICAL DRAFT COOLING TOWERS. Rochow, J.J. (Consum Power Co, Jackson, Mich). Environ. Sci. Technol.; 12: No. 13, 1379-1383(Dec 1978).

Collection and analyses of precipitation prior to and after cooling tower operation at the Palisades Plant in southwestern Michigan resulted in high deposition rates of sulfate and calcium up to 92 m from the towers. Sulfate deposition rates during operation averaged up to 9.0 g m$sup -2$ month$sup -1$ in areas within 50 m of the cooling towers and decreased to 0.61 g m$sup -2$ month$sup -1$ between 700 and 1609 m. Calcium deposition rates during operation averaged up to 4.5 g m$sup -2$ month$sup -1$ in areas within 50 m of the cooling towers and decreased to 0.57 g m$sup -2$ month$sup -1$ between 700 and 1609 m. The high sulfate deposition rates were assumed to be responsible for severe vegetation damage within 92 m of the cooling towers.

247 WET COOLING TOWERS AND RESERVOIRS, AN ALTERNATIVE TO DRY COOLING TOWERS. Steckel, H. (Bayerische Elektricitaets-Lieferungs-Gesellschaft A.G., Bayreuth (Germany, F.R.)). VGB Kraftwerkstech.; 58: No. 12, 873-877(Dec 1978). (In German).

Arzberg Power Station of the Bavarian Electricity Supply Company AG (BELG), based in Bayreuth, was extended in the period 1971 to 1974 with the installation of a 220 MW unit coupled with a wet cooling tower. Since during periods of dry weather the level of the river Roeslau, on which the power station is located, could have fallen below the minimum permissible because of the additional cooling water required to make up for losses due to evaporation, the construction of a cooling water reservoir was required by the authorities. Consequently a dam with a capacity of 1.3×10^6 m^3 been built in geologically suitable terrain in an adjacent valley rot far from the power station and this serves as a reservoir for a tributary of the Roeslau. With fuel prices being what they are, wet cooling towers in connection with cooling ponds are more economical than dry-cooling towers at least where suitable grographical and geological conditions are given. Rentability is also influenced by the climatical conditions at the process plant site as these influence the amount of evaporation losses.

248 ENVIRONMENTAL ASPECTS OF COOLING TOWER SELECTION. Kunesch, T. Process Eng.; 86-91(Nov 1978).

Ways of improving the noise, mist, and water pollution arising from the use of cooling towers in industrial and power generating plants are considered.

249 INFLUENCE OF RADIATION UPON THE HEAT TRANSFER AND LEWIS FACTOR IN EVAPORATION COOLING. Speitkamp, L.; Hartmann, H. (Technische Hochschule Aachen (Germany, F.R.). Lehrstuhl fuer Verfahrenstechnik 2). Chem.-Ing.-Tech.; 50: No. 11, 866-867(Nov 1978). (In German).

COOLING TOWERS;HEAT TRANSFER;VAPOR CONDENSATION;EVAPORATION;EVAPORATIVE COOLING; THERMODYNAMICS;DIFFERENTIAL EQUATIONS; PERFORMANCE

250 ESTIMATE COOLING TOWER REQUIREMENTS

EASILY. Meytsar, J. (Favra Int, Milan, Italy). Hydrocarbon Process.; 57: No. 11, 238-239(Nov 1978).

This paper presents and discusses three graphs which are the results of hundreds of studies of cooling towers. With these curves one will be able to approximately determine the following data related to a cooling tower: power absorbed by fans; dimensions of cooling tower; and quantity of air operated by fans. The cooling towers considered in this study have the fixed data shown. Cell widths were selected to make cooling tower dimensions easier to determine. These assumptions are accurate enough for the estimations presented.

251 TECHNICAL PROBLEMS CONCERNING NOISE IN THE CASE OF SUBSEQUENTLY EXTENDED POWER PLANTS. Scharf, H.J. Braunkohle; 30: No. 11, 327-333(Nov 1978). (In German).

The author first explains the basic principles of sound emission, then goes on to discuss the technical noise problems concerning the extension of the Wachtberg power plant. He continues by describing the noise situation in the power house and in the cooling tower. These two buildings were the main sources of noise. After a description of the causes of noise in the various types of water cooling towers possible measures of soundproofing cooling towers are discussed and finally the measures taken to soundproof the Wachtberg cooling tower are described.

252 MODERN COOLING-TOWER TECHNIQUES. Henning, H. (Balcke-Duerr A.G., Ratingen (Germany, F.R.)). Elektrizitaetswirtschaft; 77: No. 24, 829-834(Nov 1978). (In German).

The article deals with modern cooling-tower technique and its technical possibilities. Output limits and economic efficiency are discussed. Environmental questions are raised.

253 PLANT COMPRISING A POWER STATION AND A COOLING TOWER. Heeren, H. (to Maschinenfabrik Augsburg-Nurnberg Aktiengesellschaft). US Patent 4,120,162. 17 Oct 1978. Priority date 11 Nov 1975, German, Federal Republic of (F.R. Germany), 4p.

A plant including a power station with power station buildings of a heavy construction and with a cooling tower surrounding the power station buildings, especially a steam power plant with natural draft-cooling tower for dry cooling is disclosed. The cooling tower is of double mantle construction with an inner bowl and an outer bowl surrounding the inner bowl in spaced relationship thereto. The outer walls of the power plant buildings form a portion of the inner bowl or form the entire inner bowl. The remaining cooling tower portions and the outer bowl are designed as light structures. Any portion of the inner bowl which might possibly extend upwardly from the power plant buildings rest on the power plant buildings while the outer bowl on one hand rests on the ground by way of a support structure, and on the other hand by way of wind bracing members rests on the power plant buildings.

254 ICE POND COOLING OF A POWER PLANT. Geisler, G.C.; Urbanski, J.A.; Witzig, W.F. (Pennsylvania State Univ., University Park). Nucl. Technol.; 40: No. 3, 240-247(Oct 1978).

The primary objective of the study was to analyze the feasibility of using a large ice water heat sink for power plant cooling and to predict the effect of the relatively cool condenser water, produced by this system, on plant performance. For a chosen hypothetical site, the study has shown that a large ice mass could be produced during winter in northern regions and coupled with a 1000-MW(electric) nuclear power plant to provide year-round cooling water as low as 4.5°C (40°F). When introduced into the plant, this water could increase the thermal efficiency of the particular plant chosen from 34.1 to 35.4%. Although the initial cost of this system is above that of a cooling tower, the additional revenue realized through increased plant efficiency can, over the life of the plant, help to offset this increased cost.

255 REDUCING COOLING TOWER ICING POTENTIAL. Doran, W.G.; Rosenquist, W.A. (Sargent and Lundy, Chicago). Electr. Light Power (Boston); 56: No. 10, 56-57(Oct 1978).

The authors describe some of the problems associated with icing conditions on cooling towers and suggest ways to minimize freezing and reduce the chance of damage. They concentrate on the five areas where freezing is most likely to occur: the cold water basin, both the exterior and interior surfaces of the tower, areas vulnerable to ice that thaws and falls, and nearby structures. The advantages of mechanical draft towers, besides low initial cost, are due to flexible water and air control. After a tower design is selected, the authors recommend following a set of guidelines based on a thorough knowledge of both the tower and site characteristics.

256 HEAT COST IN A SWEDISH AGROTHERMAL PLANT. Christensen, J. Nucl. Technol.; 40: No. 3, 227-233(Oct 1978).

Low-grade heat is of rapidly increasing importance in Sweden and, therefore, so is the economic evaluation of such heat. The present heat cost is based on a detailed feasibility study of large-scale heated horticulture combined with electricity production from a Swedish boiling water reactor power plant. To estimate judiciously the cost of heat from a dual-purpose plant--such as a large-scale horticultural installation combined with and using low-grade waste heat from an electric power plant--is an almost classical problem: a measure of arbitrarity is unavoidable. The opportunity cost approach shown has presumably some new features. It results in an estimated cost of heat delivered from the turbine condenser heater in the power plant of 1.4 $/GJ (or 6.1 Swedish Crwn/GJ) in 1980, which is less than one-third of the cost of fuel only with conventional oil-fired heaters.

257 TEMPERATURE ADAPTATION IN THE FRESHWATER SNAIL, HELISOMA TRIVOLVIS (SAY), IN AN ARTIFICALLY HEATED RESERVOIR IN THE SOUTHEASTERN UNITED STATES. Wood, D.H. (Savannah River Ecology Lab., Aiken, SC). J. Therm. Biol.; 3: No. 4, 187-194(Oct 1978).

Snails from a heated zone of Par Pond of the U.S. Savannah River Plant were compared with conspecifics from an unheated area of the same reservoir. The heated area averaged 5°C warmer and was thermally more variable than the control area. This situation has existed for about twenty years. Variation in metabolic response to temperature was observed according to season and heated vs unheated area. A laboratory rearing experiment indicated that part of the observed variation was environmentally induced. Life cycle and growth rates were similar in the two collection areas. Three generations were produced annually in both areas and spawning was synchronous except that the summer spawning period was shorter in the heated area. Live weights expressed

relative to shell size were also similar, and decreased in both areas during summer. It appears from these results that metabolic compensation for temperature can serve as an indicator of general thermal adaptability, but only if the degree of environmental plasticity is known for the species.

258 EFFECT OF WIND ON THE OPERATION OF DRY COOLING TOWERS FOR THE CIRCULATING WATER AT THERMAL POWER PLANTS. Kuloyan, L.T.; Akopyan, L.S. (Erevan Polytech Inst, Arm SSR). Izv. Vyssh. Uchebn. Zaved., Energ.; No. 10, 141-144(Oct 1978). (In Russian).

Relying on the results of natural-size investigations, the effect of the wind on the efficiency of operation of dry cooling towers for circulating water is considered. An empirical formula for quantitative evaluation of the variations in the efficiency of operation of a cooling tower depending on wind velocity is presented.

259 BACTERIAL AEROSOLS FROM COOLING TOWERS. Adams, A.P. (US Army, Dugway, UT); Garbett, M.; Rees, H.E.; Lewis, E.G. J. Water Pollut. Control Fed.; 2362-2369(Oct 1978).

This study was initiated to evaluate the significance of bacterial aerosol production from cooling towers using waste-water effluent as makeup water by examination of types and number of microbial aerosol particles that emanate from them.

260 AIR CONDENSATION PLANTS. Kelp, F.; Pohl, H.H. (to Kraftwerk Union A.G., Muelheim an der Ruhr (Germany, F.R.); Deutsches Patentamt, Muenchen (Germany, F.R.)). German(FRG) Patent 1,962,061/B/. 14 Sep 1978. 4p. (In German).

In this plant the steam is distributed by a ventilator from the bottom to symmetrically fixed, inclined cooling elements with tubes. The upper part of the current side of the cooling elements as well as the bottom part of the outflow side can be covered by cover plates via a control circuit. This way, part of the air amount is deviated and in case of unfavourable atmospheric conditions (cold) the air is heated. This heating is enough to prevent freezing of the condensate on the cooling tubes.

261 CYCLE CONTROL CUTS COOLING-TOWER COSTS. Haupt, T. (Logic Control Syst, Redondo Beach, Calif). Chem. Eng. (N.Y.); 85: No. 20, 161-163(11 Sep 1978).

The effectiveness of pH or corrosion control is critically dependent on blowdown control. Scale inhibition is most commonly achieved by controlling pH or using threshold techniques (or both); corrosion is controlled by maintaining an inhibitor at a given concentration. Control of pH maintains calcium bicarbonate in equilibrium with some other more-soluble and -stable calcium compound, depending on the type of acid used. The purpose of the blowdown is to ensure that the saturatioin point of the resulting compound is not reached. The systems should always be run well below the saturation point of any compound, and these levels are guaranteed by analyzing the makeup water to determine the maximum concentration ratio allowable. It is pointed out that the blowdown requirement of a cooling-tower system will be minimized if the concentration ratio of the system is maintained at a constant level. Equations are derived which help to achieve this goal through necessary calculations.

262 BASIC DESIGN PRINCIPLES FOR A SEAWATER NATURAL DRAUGHT COOLING TOWER. Roggenkamp, H.E. VGB Kraftwerkstech.; 58: No. 9, 670-674(Sep 1978). (In German).

In connection with land development plans for the industrial utilization of those regions of the Federal Republic of Germany, which border on the shallows, expert opinion is to be produced, inter alia, to answer questions about possible sites for power stations. In the context of these investigations the erection of power stations on the coast of Germany in the future is now becoming conceivable and consequently closed-circuit cooling by means of seawater is no longer a Utopian scheme. Of course it has to be said by way of qualification that potential sites only on the North Sea Coast can be taken into consideration.

263 COMPARISON OF COOLING SYSTEMS FOR DRY COOLING TOWERS. Renz, U.; Becker, N. (Technische Hochschule Aachen (Germany, F.R.). Lehrstuhl fuer Waermeuebertragung und Klimatechnik). Brennst.-Waerme-Kraft; 30: No. 9, 368-370(Sep 1978). (In German).

The article compares cooling systems (gilled tubes and cooling tubes) for dry cooling towers, in respect of the resulting height of the cooling tower for a given cooling output, and in respect of the costs of the cooling tower. It deals with the basic principles of the system comparison, with the thermal and fluid-engineering comparison, as well as with the cost comparison of the various systems. Charts are added to illustrate the results of iterative calculations.

264 FOG FORMATION AT EVAPORATION COOLING. Speitkamp, L.; Hartmann, H. (Technische Hochschule Aachen (Germany, F.R.). Inst. fuer Verfahrenstechnik). Brennst.-Waerme-Kraft; 30: No. 9, 375-376(Sep 1978). (In German).

Temperature, wetness and velocity fields were spot-measured in an evaporation canal, under conditions causing fog formation in the air flow. The local condensate loading could be measured qualititively, thereby. It was possible to determine that the fog formation occurs at minute local over-saturation. The condensate loading increases also after exceeding saturation.

265 CLEANING AIR-COOLED EQUIPMENT SAVES MONEY. Blake, R.T. (Metropolitan Refining Co., Inc., Long Island City, NY). Heat., Piping Air Cond.; 50: No. 9, 105-106(Sep 1978).

For efficient and energy-conserving operation of air conditioning chillers and condensers, it is essential to have clean heat transfer surfaces. The effect of mud, dirt, and biological microorganisms on water-cooled heat-transfer surfaces has frequently been demonstrated. However, the effect of insulating deposits of mud, dirt, and dust on air-cooled condensers and air heating on cooling coils is often overlooked. This article demonstrates the effects of deposits on heat-transfer surfaces of air cooled condensers and air heating and cooling coils, and shows how energy can be saved by maintaining this equipment and keeping these surfaces clean of deposits.

266 REFLECTIONS ON THE STATE OF THE ART OF NATURAL-DRAUGHT COOLING TOWER DESIGN. Kraetzig, W.B. Bauingenieur; 3: No. 9, 341-342(Sep 1978). (In German).

The paper documents the international state

of the art of these constructions and compares it with French constructional practice. The main influencing factors, e.g. wind and solar radiation and the resulting bending stresses are discussed.

267 KEEP YOUR COOL WHEN SELECTIG THE RIGHT TOWER. Kunesch, A.M. Process Eng.; 164-165, 167(Sep 1978).
No two cooling towers perform exactly the same duty and special designs are necessary for efficient operation for various parameters. These parameters are discussed and the latest tower designs and developments are examined.

268 DRY-TYPE COOLING TOWER WITH AT LEAST APPROXIMATELY HORIZONTALLY ARRANGED HEAT EXCHANGER ELEMENTS. Heeren, H. (to Maschinenfabrik Augsburg-Nuernberg (M.A.N.) A.G., Nuernberg (Germany, F.R.); Deutsches Patentamt, Muenchen (Germany, F.R.)). German(FRG) Patent 2,708,163/A/. 31 Aug 1978. 6p. (In German).
With this additional application to P 26 12 158.4 the material consumption and cost for the installation of heat exchanger elements for dry-type cooling towers operated with overpressure is to be kept as low as possible, among other things by not using side walls for these elements resistant to bending. A supporting structure resistant to bending, made, e.g., of concrete, will, in a horizontal fitting position contain a larger number of heat exchanger elements with vertical wall surfaces non-resistant to bending. The interspaces of the elements between each other and between the surrounding inner wall of the supporting structure is filled with a pressure-resisting filler, e.g., a plastic material. This filler forms a force-locking connection between the side walls of the heat exchangers respectively, between the most exterior side walls and the inner wall of the supporting structure, thus transmitting the compressive forces produced in the heat exchanger elements by the overpressure to the supporting structure.

269 DRY-TYPE COOLING TOWER WITH AT LEAST EXCHANGER ELEMENTS. Heeren, H. (to Maschinenfabrik Augsburg-Nuernberg (M.A.N.) A.G., Nuernberg (Germany, F.R.); Deutsches Patentamt, Muenchen (Germany, F.R.)). German(FRG) Patent 2,708,162/A/. 31 Aug 1978. 6p. (In German).
With this supplement to P 26 12 158.4 the material consumption and cost for the installation of heat exchanger elements in dry-type cooling towers operated at reduced pressure is to be kept as low as possible, among other things by not using side walls for these elements that are resistant to bending. A support structure resistant to bending in an approximately horizontal fitting position can hold a larger number of heat exchanger elements with vertical wall surfaces non-resistant to bending. In the interspaces of the elements between each other and between the outer elements and the surrounding inner wall of the support structure there are mounted along the total height of the heat exchanger elements vertical tension elements. These tension elements consist, e.g., of 2 interlocking U sections passing on to the support structure the tensions produced in the heat exchangers by the subpressure. The U sections are welded to the heat exchanger walls respectively screwed to the wall of the support structure.

270 PREVENTION OF FROST DAMAGE IN DRY COOLING TOWERS. Cplatka, G. (Brown, Boveri and Co, Zurich, Switz). Brown Boveri Rev.; 65: No. 8, 555-564(Aug 1978).
Theoretical investigations have yielded the information that damage to tubes of dry cooling towers resulting from frost can be avoided without great expense and merely by observing a number of operating rules. The formation of ice can be prevented or kept within tolerable, safe limits both during steady operation and during transient conditions. The investigations carried out over the following cases: water at rest in the tube (static case); steady flow through a tube, and transient conditions, especially filling the tubes. The last mentioned case corresponds to putting a tower (or section of a tower) into service during freezing conditions. 12 refs.

271 EVALUATION OF CONCENTRATION OF COOLING MEDIUM IMPURITIES ON HEAT EXCHANGE SURFACES DURING BOILING. Tevlin, S.A. (Moscow Power Eng Inst, USSR). Teploenergetika (Moscow); No. 8, 71-74(Aug 1978). (In Russian).
An attempt is made to obtain analytical relations suitable for the calculation of the amount of the solid phase formed on the heat exchange surface when water is boiling and impurities are concentrating in the wall-adjacent layer. The calculation is based on simple balance relations under the conditions of surface and volumetric boiling. An equation is presented for the rate of formation of deposits. Experimental data obtained on a stainless steel circulation setup are compared with the calculation in iron oxide deposits on a heat emitting tube. It is shown that concentrations of chroride-containing compounds in the wall-adjacent region may be many times greater than their average content in the heat carrier.

272 TYPES OF DRY/WET COOLING TOWER CELLS. PRELIMINARY PLUME OBSERVATIONS WITH TEST CELLS IN THE GEMEINSCHAFTSKERNKRAFTWERK NECKAR (GKN). Maeule, R. (Neckarwerke Elektrizitaetsversorgungs-A.G., Esslingen (Germany, F.R.)). VGB Kraftwerkstech.; 58: No. 8, 565-570(Aug 1978). (In German).
The author reports preliminary experience with two hybrid test cooling towers in cellular design in the Gemeinschaftskernkraftwerk Neckar (GKN) with a view to technology and influence on the plumes. Depending on the occurrence of different plume-determining parameters, remarkable plume reductions have been observed as well as situations without noticeable improvement. The findings, which are ambiguous, indicate the necessity of systematic analytical investigations.

273 REVERSE OSMOSIS TO ACHIEVE WATER CONTROL AND RECYCLE. Heizer, R.T.; Plock, C.E. NWSIA J.; 5: No. 2, 21-26(Jul 1978).
A 648,000 gpd reverse osmosis (RO) facility at ERDA's Rocky Flats Plant near Golden, Colorado will convert tertiary sewage plant effluent for recycle as cooling tower makeup to reduce external water demand and achieve ''zero discharge'' off-site of tertiary sewage effluent. Design parameters for the facility, determined by three years of pilot plant testing, include 98% feedwater recovery, 100 ppM T.D.S. product water, and minimum brine production for evaporation to dryness. Pretreatment consists of RO feed attenuation in a large pond, chlorination, sand filtration, softening, diatomaceous earth filtration, feedwater heating and pH adjustment. The RO plant will have three 150 gpm trains, each with a combination of HFF modules producing about 90% of the permeate, followed by SW modules

producing the final 10%. Permeate from the SW modules can be combined with permeate from the HFF modules or returned to the RO feed stream. Unique design considerations include heating the 40 to 70°F fee to 77°F by means of heat recovery from the permeate and supplemental steam heating, recycling of pretreatment backwash streams wherever possible to reduce the volume of brine, and precautions to avoid silica scaling of the modules.

274 JOURNAL OF THE MINE VENTILATION SOCIETY OF SOUTH AFRICA. Pretorius, E.C.B. (Loraine Gold Mine, Ltd). J. Mine Vent. Soc. S. Afr.; 31: No. 7, 121-129(Jul 1978).
The development of horizontal spray chambers was prompted by the need to find an alternative to conventional cooling coils because of severe corrosion problems which limited the life of the coils. After the installation of the first two stage cooling spray chamber, further spray chamber, both for cooling and heat rejection, were installed. Performance figures are stated and comparisons are made with cooling tower performance figures. 1 ref.

275 OPERATIONAL EXPERIENCE WITH A BASF DRY/WET COOLING TOWER. PT. II. THERMODYNAMIC INVESTIGATIONS. Kokott, D. (BASF A.G., Ludwigshafen am Rhein (Germany, F.R.)). VGB Kraftwerkstech.; 58: No. 7, 492-499(Jul 1978). (In German).
The experimental findings have shown that steam condensation in the cooling tower plume can be suppressed at least in the direct neighbourhood of the plant by combining indirect air cooling and evaporation cooling. Plume formation could be prevented down to an ambient temperature of -5°C. If the temperature dropped further for a short period of time, plume formation was still prevented but measurement was no longer possible. Recondensation of the plumes in greater heights was not observed during the whole observation period from December 1977 to April 1978, where marked temperature minimum values were measured. The main factor in the calculation of dry/wet cooling towers is the water supersaturation in the waste air of the wet part which has been determined in experiments.

276 FLOW IN CONTROL VALVES AS A SOURCE OF NOISE. Nuding, W. Regelungstech. Prax.; 20: No. 7, 194-199(Jul 1978). (In German).
The main cause of noise during liquid flow in valves is the cavitation which sets on when the steam pressure of the liquid is reached.

277 METHOD OF WASTE HEAT TRANSPORTATION. Alefeld, G. (to Deutsches Patentamt). German(FRG) Patent 2,655,688/A/. 15 Jun 1978. 3p. (In German).
It is proposed to use the high-pressure gas, produced according to the method described in application no. 26 49 726, for the following purposes: (1) as heat transfer medium between a power plant and a dry-type cooling tower, and (2) for transporting waste-heat from coal mines to the consumer. It is of advantage to use a gas mixture consisting of NH_3 and CO_2 with a mole ratio of 2:1.

278 EFFECT OF THE BROADLANDS GEOTHERMAL POWER SCHEME ON THE WAIKATO RIVER. Willis, D.J. (N.Z. Electric Dept., Power Station Siting Sect.). Geotherm. Energy Mag.; 6: No. 6, 25-34(Jun 1978).
This paper briefly describes the power production process to be applied at Broadlands and details geothermal wastes that could affect the Waikato River. It further outlines alternative waste disposal methods as well as some possible consequences to the Waikato River if the said wastes are disposed of in an uncontrolled manner. It is concluded that if cooling towers are used for closed cycle condenser cooling and waste borewater is disposed of by injecting back into the formation from which it came, then the effect of the power scheme on the Waikato River would be negligible. 6 refs.

279 DEVELOPMENT AND CONSTRUCTION INVESTIGATION FOR A HIGH-POWER COMBINED WET/DRY COOLING TOWER. Maeule, R. (Neckarwerke Elektrizitaetsversorgungs-A.G., Esslingen (Germany, F.R.)). VGB Kraftwerkstech.; 58: No. 6, 455-457(Jun 1978). (In German).
According to unverified information by different producers, investment costs for hybrid cooling towers are twice as high as those for wet cooling towers or even higher. The full effect of this system on plume diffusion is as yet unknown. This point will have to be solved before secondary problems of interest, e.g. water saving, materials selection, noise, etc. can be tackled.

280 NEW WAY IN COOLING. COOLING ELEMENTS - REVERTING THE PRINCIPLE OF OPERATION IMPROVES PERFORMANCE. Energy Dev. (Graefelfing); 2: No. 2, 7-10(Jun 1978).
Highly praised as a sensation on the one hand, labeled as a dubious technique on the other hand, a development of cooling towers by M.A.N. (Maschinenfabrik Augsburg-Nuernberg) evoked a keen discussion in the branch of constructors and operators of cooling towers. According to M.A.N. the 'LRT-element (for Luftrohr-Trockenkuehl-Element) is supposed to produce an intensified efficiency for power plants. The cooling medium is air; thus the procedure is even more interesting for arid countries than for the Federal Republic of Germany.

281 THERMAL EFFECTS. Talmage, S.S.; Coutant, C.C. (Oak Ridge National Lab., TN). J. Water Pollut. Control Fed.; 1514-1553(Jun 1978).
A literature review of temperature effects on the aquatic environment is presented. The literature reviewed covers marine ecosystems in rivers, lakes, cooling ponds, estuaries, and marine sites. There are 8 tables summarizing the effects of temperature on reproduction, embryonic development, larval development, distribution, tolerance, oxygen metabolism, growth, and interaction of other stresses on a wide variety of aquatic organisms. There are 400 references cited.

282 DRY/WET WATER COOLING TOWER VENTILATED FROM GROUND LEVEL. Houx, J.R. Jr.; Landon, R.D.; Lindahl, P.A. Jr. (to Marley Co., Mission). German(FRG) Patent 2,751,14. /A/. 24 May 1978. 31p. (In German).
A cooling tower is described which gives off air in such a manner that the inner, hot and moist air is at least partly enclosed in hot dry air so that moisture deposition on near-by installations is kept at a minimum level.

283 PRESENT KNOWLEDGE OF PHYSICAL RELATIONSHIPS IN DRIFT EMISSION FROM WET COOLING TOWERS AND MEASURES TAKEN TO DATE FOR DETERMINING DRIFT DIMENSIONS. Vodicka, V. (Balcke-Duerr A.G., Bochum (Germany, F.R.)).

VGE Kraftwerkstech.; 58: No. 5, 337-342(May 1978). (In German).
Cooling towers of present day construction are fitted with eliminators. In addition to knowledge of drift loss is also of interest. The paper presents theoretical possibilities of improving the collecting efficiency of drift eliminators. These theories are confirmed by measurements. In addition methods of drift emission rates and of determining drift dimensions are presented. In conclusion the drift spectra of various drift eliminator and cooling tower designs are indicated.

284 CONTROL OF COOLING WATER TREATMENT: A STATISTICAL STUDY. Schieber, J.R. (Betz Lab., Inc.). Combustion; 49: No. 11, 25-30(May 1978).
Results show that most industrial plants using manual methods of treatment control do not maintain satisfactory water balances. Corrosion and fouling rates are considerably higher than necessary. Automatic control improves protection of the system and increases operating efficiency. For this study, typical reports were obtained at random from the records for several hundred plants. The only selectivity was that each plant included in the survey fed sulfuric acid, did not employ automatic control and required blowdown.

285 NOISE EMISSION CHARACTERISTICS OF CIRCULAR MECHANICAL NATURAL AND FAN-ASSIST NATURAL DRAFT COOLING TOWERS WITH SILENCERS. Capano, G.A. (Stone and Webster). Combustion; 49: No. 11, 36-40(May 1978).
For power plants utilizing large, wet-style cooling towers, increasing significance is being attributed to the noise control measures needed to counteract cooling tower impacts to the adjacent community. Understanding the noise emission and propagation characteristics at the inlet and outlet of towers and defining the level of noise and its frequency content at any distance from the tower are prerequisite to initiating effective noise control measures. To provide this information noise measurements were taken at several plants in West Germany. Circular mechanical draft, fan-assist, and hyperbolic natural draft towers used in Europe were found to be similar to United States' style towers as to noise level at the inlet (85-86 dBA on the average) but exhibited different outlet noise emission characteristics than had been simulated by model tests.

286 CROSS WIND AND INTERNAL FLOW CHARACTERISTICS OF DRY COOLING TOWERS. Russell, C.M.B.; McChesney, H.R.; Holder, D.W.; Jones, T.; Verlinden, M. (C-E Lummus, Combustion Engineering Inc.). Combustion; 49: No. 11, 20-24(May 1978).
In order to investigate new concepts in the design of natural draft dry cooling towers, the authors in association with Oxford University, have undertaken a program of research to determine how the arrangement of heat exchanger bundles at the base of a tower affects the tower's internal flow and its sensitivity to cross winds. To learn more about these effects, experiments were conducted with model towers in which heat exchanger bundles were represented by gauze screens. Two types of tests were performed. The first was a study of tower flow in the absence of cross winds which was made at high Reynolds numbers, and the second, a study of cross-wind effects made at much reduced Reynolds numbers in a 4m*2m wind tunnel. 8 refs.

287 PERFORMANCE AND CAPITAL COSTS OF WET/DRY COOLING TOWERS IN POWER PLANT SERVICE. Larinoff, M.W. (Hudson Products Corp.). Combustion; 49: No. 11, 9-19(May 1978).
Dry and wet-peaking tower cooling systems in power plant applications provide the means for saving evaporative cooling makeup water supplies. A 1000 Mw LWR nuclear plant operating at rated load with an all-wet cooling tower requires about 20,000,000 gallons of makeup water every 24 hours. A question frequently asked is, what is the capital cost of these water-saving systems compared to all-wet or all-dry cooling towers. There have been three recently published reports, prepared under the sponsorship of ERDA and RPRI, that evaluate the total costs of these wet/dry tower cooling systems. This paper extracts the capital costs of these cooling systems from these reports and compares the findings of the three Consultants. In addition, the capital costs of the cooling system equipment so derived are presented in tabular and plotted form for use as ''estimating tools'' by the industry. [illegible] refs.

288 OPERATION OF STEAM TURBINES WITH DRY COOLING TOWERS. Schwarzenbach, A. (BBC Brown, Boveri and Co., Ltd.). Combustion; 49: No. 11, 33-35(May 1978).
The article describes the use of dry-type cooling towers in the operation of power plants equipped with Brown, Boveri and Company, Ltd. (BBC)'s steam turbines. The use of dry cooling towers in this application is especially suitable in the areas where water is in short supply, or where environmental protection measures are imposing limits on the amount of water that may be used for cooling purposes. Experience gained in a Hungarian power plant proves that BBC steam turbines can be expected to perform reliably in combination with dry cooling towers. 8 refs.

289 PRESERVATIVE TREATMENT OF COOLING TOWER LUMBER. Hutton, D. (BAC-Pritchard, Inc., Baltimore, MD). Heat., Piping Air Cond.; 50: No. 5, 71-75(May 1978).
The reasons for preservative treatment of cooling tower wood are reviewed along with a summary of which types of treatment are available, how they are applied, and a comparison of materials and processes. Industries often specify minimum quality preservatives for their cooling towers without understanding the loss of strength caused by decay and the economic losses due to a cooling tower failure and lost production. Wood is subject to both chemical (surface delignification and iron rot) and biological (soft rot) attack. A successful preservative treatment that protects against both must have retention and penetration qualities. Research efforts are examining the toxicity and environmental impacts of preservatives and exploring the possibility of chemically modifying wood. (DCK)

290 IN AQUA VERITAS - WATER TREATMENT IN CONVENTIONAL POWER PLANTS. PROCESS ALTERNATIVES. Bursik, A. (Grosskraftwerk Mannheim A.G. (Germany, F.R.)). Energie; 30: No. 4, 126-129(Apr 1978). (In German).
Different methods of water treatment in conventional power plants are described. Some techniques to treat fresh water, condensate, cooling tower fresh water, and waste water are discussed.

291 OPTIMIZATION OF LOW-POTENTIAL COMPLEX OF NUCLEAR POWER PLANTS WITH A MIXED SYSTEM OF

CIRCULATING WATER SUPPLY. Berman, L.D.; Popyrin, L.S.; Zisman, S.L.; Mai, V.A.; Naumov, Yu.V. (All-Union Heat Eng Inst, USSR). Teploenergetika (Moscow); No. 4, 38-42(Apr 1978). (In Russian).

The region of rational utilization of mixed circulating systems of water supply with a water cooling reservoir and cooling towers in application to nuclear power plants with 1000 MW blocks is investigated. The optimal structure of such a system of water supply with different dimensions of the water cooling reservoir, the optimal load on the latter, and optimal parameters of the low-potential complex of nuclear power plants with a mixed circulating water-supply system are determined.

292 HEAT EXCHANGERS. Stephan, K.; Mitrovic, J. Brennst.-Waerme-Kraft; 30: No. 4, 188-193(Apr 1978). (In German).

The literature survey lists mainly those papers which give a contribution to the mechanical, thermic, and fluid-dynamic design of heat exchangers. The convective heat transfer without phase transition is discussed in consideration of free and forced convection on bodies of different geometries.

293 OPTIMIZATION OF LOW-POTENTIAL COMPLEX OF NPP WITH MIXED CLOSED-CYCLE WATER COOLING SYSTEM. Berman, L.D.; Popyrin, L.S.; Zisman, S.L.; Mai, V.A.; Naumov, Yu.V. Teploenergetika (Moscow); No. 4, 38-42(Apr 1978). (In Russian).

The results of optimal design calculation of a circulation water cooling system in an NPP, whose power is stepped up from 2000 to 4000 MW are presented. It is assumed that the NPP comprises power plant units with a WWER-1000 reactor and saturated 6.5 MPa steam turbine of 1000 MW capacity. For two climatic zones of the European part of the USSR - the Center and the South - the possibility of raising the thermal load of the existing reservoir-cooler (R-C) system or using instead a combination of R-C plus cooling tower system is considered. It is shown that when the combination of R-C and cooling towers is used the low-potential complex parameters correspond to those of the most expensive part of the combined cooling system - the cooling towers.

294 COOLING TOWER, ESPECIALLY FOR THERMAL POWER PLANTS. Sonnenschein, H. (to Deutsches Patentamt). German(FRG) Patent 2,640,177/A/. 16 Mar 1978. 19p. (In German).

A novel method of construction is proposed for cooling towers exhibiting especially large capacities. Instead of conventional materials, the shell structure of the stack consist of some kind of air-carried hall filled with a gas which is lighter than air (helium or hot air). There must be a flow duct, running through the whole structure, in order to be able to discharge the hot air. A flexible design permits adaption in size and height to operational as well as environmental conditions. Several design variants are described.

295 COOLING TOWER. Kessler, E. (to Krupp (Friedr.) G.m.b.H., Essen (Germany, F.R.); Deutsches Patentamt, Muenchen (Germany, F.R.)). German(FRG) Patent 2,105,174/C/. 2 Mar 1978. 4p. (In German).

A rope-network cooling tower is presented, where a rope structure, supported by a central bearing pile by means of an upper spacer ring and at least another ring and forming the shell of the cooling tower, is connected with the foundation. Characteristic is here the run of the ropes, having got the same radial distance from the middle axis between the upper end lower spacer ring and showing the same straight run towards the foundation.

296 OPTIMIZATION OF CLOSED CIRCUIT COOLING SYSTEMS, WITH NATURAL DRAFT TOWER, FOR POWER PLANT CONDENSERS. Genco, G.; Martelli, F.; Senis, R. (ENEL--Cent Prog e Costr per gli Impianti Nucl, Rome, Italy). Termotecnica (Milan); 32: No. 3, 134-145(Mar 1978). (In Italian).

A calculation method to determine the optimal characteristics of closed-circuit cooling systems, with natural draft tower, for power plant condensers is developed. After having identified the essential parameters of a cooling system and established the equations which define its behavior under non-rated conditions the objective junction, representative of the total system cost, including operating costs, was determined as well as the minimum of that function. In this connection, a computer program is presented and an application for nuclear power station is given.

297 FORCED CONVECTION HEAT TRANSFER IN AN ANNULUS AT LOW REYNOLDS NUMBERS . Bisio, G.; Pisoni, C. (Univ degli Studi di Genova, Ist de Fis Tecn e Impianti Termotec, Italy). Termotecnica (Milan); 32: No. 3, 146-153(Mar 1978). (In Italian).

Results are presented of an experimental investigation on heat transfer with air in forced convection flow in an annulus with a heated core at uniform temperature and an insulated outer wall, at low Reynolds numbers (Re=700/2200). Referring to analytical investigations on the subject, developed on the basis of constant fluid properties, a comparative analysis is carried out between the experimental and theoretical data on temperature distributions and heat fluxes, at the aim of evaluating the effect of fluid properties variation on heat transfer problems. 12 Refs.

298 COOLING POWER TECHNOLOGY AT A TURNING POINT. Hese, L.H. Waerme; 84: No. 3, 50-51(Mar 1978). (In German).

From freshwater cooling and efflux condenser cooling to wet recirculation cooling, hybrid and dry cooling towers, cooling tower technology has seen a development characterized by higher cooling tower costs and reduced power plant efficiency. Therefore, all research work done at the moment concentrates on making up for the economic losses connected with improved environmental protection.

299 AIR FROM NEW PIPES. M.A.N. HAS DEVELOPED A NEW DRY-COOLING SYSTEM. Energie; 30: No. 3, 74-75(Mar 1978). (In German).

The new dry-cooling system method LRT (Luftrohr-Trockenkuehlturm) developed by M.A.N. is designed so that the surface touched by the air is on the inner side of the pipe. Air and water-touched surfaces are hence practically equal in area without using ribs. In order to transfer an equally large amount of heat, one requires a considerally smaller air-side resistance with the LRT element compared to the outer ribbed pipe. The joining of the binary turbine to the direct process of dry cooling using the LRT element greatly increases the useful heat gradient for the turbine. The primary energy utilization is thus improved and

hence less burdening of the environment. The working agent for the binary process is MWA (methoxy propanol-water azeotrope) having high heat transfer values, is non-toxic and biologically decomposable. Compared to common construction materials in turbine building, it is not aggressive. MAN is planning a dry cooling tower according to the LRT system Nuernberg's own power plant.

300 PREDICTING SALT COMPOSITION OF WATER IN CIRCULATORY COOLING SYSTEMS. Kot, A.A.; Bodnar', Yu.F.; Gronskii, R.K. (All-Union Heat Eng Inst, USSR). Teploenergetika (Moscow); No. 3, 58-60(Mar 1978). (In Russian).

A method and formulas are presented for the calculation of the variation of the salt composition of circulating water in circulatory cooling systems. The succession of calculations is shown by examples. The method in question makes use of the following concepts: degree of system equilibrium S, multiplicity of water reuse K, salinity factor f.

301 NATURAL-DRAUGHT COOLING TOWERS MADE OF REINFORCED CONCRETE. STATE OF THE ART AND DEVELOPMENT POSSIBILITIES. Kraetzig, W.B.; Peters, H.L.; Zerna, W. Beton Stahlbetonbau; 73: No. 3, 66-72(Mar 1978). (In German).

Large power plant units and dry cooling tower technology require larger dimensions for natural-draught cooling towers. The main curvation radii in latitudinal and meridian direction are thus increased, which results in a lower three-dimensional support strength. This development is an incentive for constant re-consideration of calculation methods, safety philosophy, and dimensioning criteria. In this context, wind effects have been re-formulated and given a scientific foundation. Constructional measures to improve the static and dynamic behaviour of the structure have been presented and critically assessed. A cost analysis, finally, gave the most rational applications of the new shell construction with reinforcing elements. A cooling tower now under construction gave a realistic example. Fundamental aspects concerning the foundations of cooling tower shells and two special types of foundation are further points to clarify the subject.

302 COOLING TOWER WITH MECHANICAL AND NATURAL DRAUGHT. Kelp, F. (to Kraftwerk Union A.G., Muelheim an der Ruhr (Germany, F.R.)). German(FRG) Patent 2,636,807/A/. 23 Feb 1978. 7p. (In German).

A cooling tower is described which can be operated with natural as well as with mechanical draught, where the cooling power is not much reduced when the blowers are shut off.

303 HEAT REJECTION SYSTEM. Smith, G.C.; Tokarz, R.D.; Parry, H.L. Jr.; Braun, D.J. (to Department of Energy). US Patent Application 680,254. 22 Feb 1978. 12p.

A cooling system for rejecting waste heat is described. The system consists of a cooling tower incorporating a plurality of coolant tubes provided with cooling fins and each having a plurality of cooling channels therein, means for directing a heat exchange fluid from the power plant through less than the total number of cooling channels to cool the heat exchange fluid under normal ambient temperature conditions, means for directing water through the remaining cooling channels whenever the ambient temperature rises above the temperature at which dry cooling of the heat exchange fluid is sufficient and means for cooling the water.

304 COOLING TOWER. Kessler, E. (to Krupp (Friedr.) G.m.b.H., Essen (Germany, F.R.); Deutsches Patentamt, Muenchen (Germany, F.R.)). German(FRG) Patent 2,142,491/C/. 16 Feb 1978. 2p. (In German).

The invention is concerned with mounting a tense net of ropes carrying the cover forming the shell of the cooling tower. According to the invention the net of ropes is held near the outlet opening by spacer rings being connected with the mast of the cooling tower by means of prestressed spokes which can be loaded in tension.

305 NATURAL-DRAFT COOLING TOWERS MADE OF REINFORCED CONCRETE - CURRENT STATUS AND POSSIBILITIES OF DEVELOPMENT. Kraetzig, W.B.; Peters, H.L.; Zerna, W. Beton Stahlbetonbau; 73: No. 2, 37-42(Feb 1978). (In German).

For the construction of all kinds of cooling towers all over the world, the design with steel concrete has proved to be a problem-adequate and economical technology. Together with the unit sizes of power stations, the dimensions of the coolers began to grow to gigantic proportions. This process of growing was not even interrupted by the collapse of three cooling towers of a height of 114 m at Ferrybridge and another tower at Ardeer. On the contrary, the cases of damage led to more intensive international research helping to close many gaps in the knowledge about the load carrying behaviour of natural-draft cooling towers. Alone in the Federal Republic of Germany, more than 50 large natural-draft cooling towers, serving the power supply without faults and cracks, give evidence of the reliability of these structures.

306 COOLING WATER SYSTEMS: TREATMENT AND MATERIALS OF CONSTRUCTION. DeMonbrun, J.R. (Union Carbide Corp., Oak Ridge, TN). Am. Inst. Plant Eng. J.; 5: No. 4, 39-43(Win 1978).

A cooling water system presents a significant challenge to the plant engineer. Materials and manpower costs continue to rise higher and higher, but corrosion recognition and control provides many cost-reducing opportunities. To be effective, however reliance must be made on the knowledge of others in the field of chemistry, metallurgy, electricity, biology, geology, and metrology, to name a few. Several areas that need considerable attention in a cooling water system are discussed as well as potential problems including impurities in water; types of chemicals for corrosion, scale and microbiological control; cooling tower materials of construction; drift; and blowdown.

307 ENVIRONMENTAL IMPACTS OF INDUSTRIAL ENERGY SYSTEMS IN THE COASTAL ZONE. Hall, C.A.S. (Cornell Univ., Ithaca, NY); Howarth, R.; Moore, B. III; Voeroesmarty, C.J. Annu. Rev. Energy; 3: 395-475(1978).

Impacts from energy-related industry situated or operating in coastal regions are reviewed. Aquatic ecosystems response to primary and synergistic effects have been assessed for petroleum industry wastes as well as for clean-up and abatement efforts. Power plant impacts have been found to be extremely site-dependent, and need for universal environmental standards has not been shown. 673 notes and references. (PCS)

308 DIFFERENCES IN ATMOSPHERIC CONVECTION CAUSED BY WASTE ENERGY REJECTED IN THE FORMS OF SENSIBLE AND LATENT HEATS. Koenig, L.; Murray, F.W.; Tag, P.M. (Rand Corp). Atmos. Environ.; 12: No. 5, 1013-1019(1978).

The relative ability of continuous sensible and latent heat perturbations to initiate atmospheric convection is studied using numerical simulation. In three experiments a given amount of energy is rejected as all sensible heat, all latent heat, and half sensible and half latent heat. With equal heat flux desnity, sensible heat is much more likely to initiate convective circulations and anomalous cloudiness than latent heat. These findings indicate that to the extent that the potential for cloud initiation is a factor in the choice, wet cooling towers are preferable to dry ones for the rejection of large quantities of heat. 10 refs.

309 DRIFT MODELING AND MONITORING COMPARISONS. Chen, N.C.J. (Oak Ridge National Lab., TN); Hanna, S.R. Atmos. Environ.; 12: 1725-1734(1978).

Ten drift deposition models are compared using a set of standard input conditions for a natural draft cooling tower. Most of the models agree within a factor of three. However when all ten models are compared, the predicted maximum drift deposition differs by two orders of magnitude, and the downwind locations of the maximum differ by one order of magnitude. The discrepancies are attributed mainly to different assumptions in the model regarding the initial effective height of the droplets. Current programs measuring drift characteristics at the tower mouth and drift deposition downwind of the tower are summarized. At the present time, drift deposition measurements, sufficiently comprehensive for model verifications, are unavailable. Hopefully, the Chalk Point Program will satisfy this need.

310 OBSERVATION OF COOLING TOWER PLUME EFFECTS ON TOTAL SOLAR RADIATION. Ryznar, E. (Univ of Mich, Ann Arbor). Atmos. Environ.; 12: No. 5, 1223-1224(1978).

Measurements of total solar radiation were made on 7 March 1977. The sky was cloudless but a cooling tower plume occasionally came between the sun and the pyranometer that was used. These measurements resulted in values that were greater than those expected with a cloudless sky. It is likely that reflections from the plume, whose average position was slightly north of an imaginary sun-pyranometer line, were responsible. 5 refs.

311 DIFFERENCES IN ATMOSPHERIC CONVECTION CAUSED BY WASTE ENERGY REJECTED IN THE FORMS OF SENSIBLE AND LATENT HEATS. Koenig, L.; Murray, F.W.; Tag, P.M. (Rand Corp). Atmos. Environ.; 12: No. 5, 1013-1019(1978).

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312 PIPELINE FROM OCEAN TO DESERT TO PROVIDE COOLING FOR SOLAR POWER PLANT COMPLEX. Turner, R.H. (Jet Propulsion Lab., Pasadena, CA). pp 845-849 of Solar diversification. Vol. 2.1. Boeer, K.W.; Franta, G.E. (eds.). Newark, DE; American Section of the International Solar Energy Society, Inc. (1978).

From Meeting of the American Section of the International Solar Energy Society; Denver, CO, USA (28 Aug 1978).

A prime factor in large-scale development of solar power plants is lack of water for condenser cooling, since if the facility is located in arid and low population density areas to take advantage of high insolation values and low land costs, then water will likely be unavailable. One possible way to provide water for condenser cooling to Southern California desert power plant sites is to construct a pipeline or aqueduct from the ocean to the desert and pump sea water to the site. Since such a project would necessarily be large-scale, the site would probably be a complex of power plants, and need not be restricted to solar units. JPL has conducted a preliminary study to assess the technical and economic feasibility of such a scheme. Three possible condenser cooling modes are considered, including seawater makeup to (1) wet cooling tower, (2) evaporation cooling ponds, and (3) inverse salt gradient solar ponds where low grade heat would also be collected. Pump power requirements appear to be relatively small. Several techniques are considered for the disposal of concentrated brine, including the introduction of ancillary and complementary industries including salt and distilled water production and chemical production. A fallout from such a project would be the introduction of evaporated water into the desert biosphere. Preliminary results are described and potential advantages and disadvantages are listed.

313 REVIEW OF THE ENVIRONMENTAL EFFECTS OF THREE SOLAR ENERGY TECHNOLOGIES. Lawrence, K.A. (Solar Energy Research Inst., Golden, CO). pp 592-596 of Solar diversification. Vol. 2.2. Boeer, K.W.; Franta, G.E. (eds.). Newark, DE; American Section of the International Solar Energy Society, Inc. (1978).

From Meeting of the American Section of the International Solar Energy Society; Denver, CO, USA (28 Aug 1978).

No method of energy production is without some environmental effects. Solar energy technologies are no different. Data are reviewed and summarized on the environmental effects of three solar energy technologies: photovoltaic cells, wind energy conversion (WEC), and the solar thermal central receiver. Potential effects are identified for each of the life cycle phases: resource extraction and component manufacture, plant construction, operation, and decommission. The solar energy technologies are assumed to be deployed as a centralized energy production facility. The technologies examined are materials intensive compared to fossil fuel plants with the same power rating. As a result, the life cycle phase of resource extraction and component production is the most environmentally hazardous. Impacts of plant construction will be somewhat site specific but should approximate impacts associated with any large construction activity. The operation phase is relatively environmentally benign. None of the options emit air or water pollutants. WEC operation does produce low-level noise pollution and present hazards to flying species. Solar thermal facilities equipped with wet cooling

towers may affect local air quality via cooling tower drift. Decommission of WEC, solar thermal, and Si-photovoltaic facilities should present no environmental hazards, although disposal of CdSGaAs cells will require care.

314 COOLING TOWER TECHNOLOGY--COLD WATER MAKES PROFITS. Burger, R. (Robert Burger Assoc, New York, NY). Ind. Water Eng.; 15: No. 4, 14-18(1978).

The criterion of cooling tower performance is outlined in the design conditions described, specified when the cooling tower is purchased and/or rebuilt to mean the cooling of a specific quantity of circulating water from entering the tower at a particular temperature and leaving at a definite value. Enthalpy pressure diagram presented relates cold water to energy required for refrigerant utilization.

315 OBSERVATIONS AND PREDICTIONS OF NATURAL DRAFT COOLING TOWER PLUMES AT PARADISE STEAM PLANT. Slawson, P.R. (Univ of Waterloo, Ont). Atmos. Environ.; 12: No. 8, 1713-1724(1978).

Observations of the time-mean plumes from the natural-draft cooling towers at the Tennessee Valley Authority's Paradise Steam Plant taken during the winter of 1973 are compared with a one-dimensional model for moist plume behavior. A bent-over plume model based on the closed form solution to the integral form of the governing equations for plume behavior for an atmosphere of linear stable stratification was found to adequately describe most of the observed plume trajectories and visible lengths. However, numerical integration of the equations are required to account for detailed effects of vertical wind shear and elevated inversions on plume trajectory. Plume trajectory and visible length are greatly influenced by tower downwash. 21 refs.

316 VELOCITY DISTRIBUTIONS AND TURBULENCE INTENSITIES AT TUBESHEETS IN A TWO-PASS CONDENSER MODEL. March, P.A. (Alden Res Lab, Holden, Mass). Am. Soc. Mech. Eng., [Pap.]; No. 78-JPGC-NE-6, 1-6(1978).

A 1:7.8 scale hydraulic model was used to determine flow patterns, velocity distributions, and turbulence intensities within the inlet/outlet waterbox and reversing waterbox of a two-pass condenser for a nuclear generating station currently under construction. A laser doppler anemometer with an acousto-optical frequency shifter was used to measure the velocity components perpendicular to the tubesheets and the turbulence intensities associated with these components. Test results were discussed in terms of their implications for tubesheet and condenser tube erosion. 9 refs.

317 WIND ENERGY GENERATION WITH HYPERBOLIC COOLING TOWERS. Rogers, P. (Calif State Univ, Los Angeles). pp vp of Greater Los Angeles Area energy symposium. North Hollywood, CA; West Period Co. (1978).

From 4. energy symposium; Los Angeles, CA, USA (23 May 1978).

The method described in this article pertains to the secondary utilization of the exterior of hyperbolic cooling tower shells for supporting wind-rotors, and for producing electric energy directly and at a very reduced cost.

318 FLOW LOSSES IN OBLIQUE HEAT-EXCHANGERS FOR DRY COOLING TOWERS OF LARGE POWER PLANTS. Pimputkar, S.M. Ithaca, NY; Cornell Univ. (1978). 132p. University Microfilms Order No. 78-17,875.

Thesis (Ph. D.).

Heat-exchangers of dry cooling towers for large power plants have big frontal areas to reduce the fan-power (or equivalently, the draft height). Such large frontal areas are commonly accommodated by arranging the heat-exchangers in a ''folded'' or ''zig-zag'' configuration. Thus the flow upstream is not perpendicular to any heat-exchanger face. These heat-exchangers, yawed with respect to the incoming flow, have total pressure losses which exceed the static pressure drop for the unyawed case. Additional losses which arise as a consequence of oblique positioning are identified and discussed. A stack of Hele-Shaw cells between plates of parallelogram planform is used to simulate a high drag heat-exchanger. The flow within the plates is solved analytically. It is then shown that vorticity is generated at the corners during diffusion of the parabolic profile to a uniform one immediately behind the heat-exchanger. The magnitude of this vorticity scales with the transverse gradient of emerging velocity at the rear of the heat-exchanger. The upstream and downstream flow fields are then computed numerically. The downstream solution is unique but a consequence of allowing only laminar, unseparated flow is that the usual boundary condition of normal emergence from the rear of a high drag heat-exchanger is not satisfied. However the streamlines obtained give the unique directions along which the flow should be constrained to leave the rear face of the heat-exchanger by means of an appropriately designed cascade in order to have no separation downstream. Design suggetions for reducing oblique flow losses are discussed.

319 WASTE HEAT DISPOSAL TO AIR WITH FORCED AND NATURAL DRAFT: SOME ANALYTICAL DESIGN CONSIDERATIONS. Montakhab, A. Stanford, CA; Stanford Univ. (1978). 227p. University Microfilms Order No. 78-14,193.

Thesis (Ph. D.).

The main objective of this work is to quantify the factors which reduce the overall size and cost of the cooling tower and the associated heat transfer system for thermal power plants and to establish the conditions which result in dry cooling tower cost reductions. The fundamental design aspects of large air-cooled power stations are discussed and economic and technical considerations of using dry and wet/dry cooling systems for electric power stations are presented. As a first step, the design equations for forced- and natural-draft dry cooling towers are derived in closed form to give explicit relations for salient design variables. Subsequently, these equations are used to establish a set of influence coefficients for the design, performance evaluation, and optimization of dry cooling towers and for quantifying the effects of various key design variables on the design of forced- and natural-draft dry cooling towers. The use of influence coefficients in the sizing of a natural-draft cooling tower for a nuclear gas turbine with a 1200 MW(e) output is illustrated. Optimization conditions for dry cooling towers are presented. These conditionsare applicable to the design optimization of the dry-cooled steam condenser and the dry-cooled precooler of a closed-cycle gas turbine. It is concluded that the optimum coupling liquid capacity rate and the optimum heat transfer surface area distribution between the condenser and the dry cooling tower are not critical. The effects of heat transfer surface geometry on the design of

dry cooling towers is investigated, and criteria for evaluation of heat transfer geometries are established which may be used in the selection of heat exchanger surface or in directing research and development efforts toward manufacturing of improved heat transfer surfaces for the dry cooling tower applications.

320 Kriterien zur Optimierung des Baues von Grossnaturzugkuehltuermen im Hinblick auf Standsicherheit, Bauausfuehrung und Wirtschaftlichkeit. (CRITERIA FOR STRUCTURAL OPTIMIZATION OF NATURAL-DRAUGHT COOLING TOWERS WITH A VIEW TO STABILITY, CONSTRUCTION, AND RENTABILITY). Zerna, W.; Haj-Issa, S.; Lehmkaemper, C.; Mungan, I. (Bochum Univ. (Germany, F.R.). Inst. fuer Konstruktiven Ingenieurbau). Opladen, Germany, F.R.; Westdeutscher Verl. (1978). 65p. (In German).

There are a number of possible designs for future natural-draught cooling towers. Apart from the well-tried reinforced-concrete construction with variable shell thickness, constructions with bracings or cable net constructions are possible. Bracing rings are indispensible in large cooling towers as they have a favourable effect on the buckling and vibrational behaviour of the cooling tower. This design is also more economical than cooling tower shells with variable thickness.

321 ANALYSIS OF THE OPERATION OF ATMOSPHERIC COOLANTS. Aussourd, P.; Bourillot, C.; Caudron, L.; Mery, P. Entropie; No. 83, 61-74(1978). (In French).

The operation of cooling towers is discussed. The present state of knowledge of the thermodynamics of cooling towers, the dynamics of condensation plumes and their effects on the environment are described. Finally, current problems in atmospheric cooling and the different means used to improve currently used techniques are discussed.

322 COOLING TOWERS, DESIGN AND PLUME BEHAVIOR. Ernst, G. (Univ., Karlsruhe, Germany). pp 229-236 of Thermal effluent disposal from power generation. Zaric, Z.P. (ed.). Washington, DC; Hemisphere Publishing Corporation (1978).

From International advanced course on heat disposal from power generation; Dubrovnik, Yugoslavia (23 Aug 1976).

Advantages and disadvantages of variations on the two basic types of cooling towers, wet and dry, are discussed. Results of studies on plume behavior in natural-draft wet cooling towers (with counter flow) are summarized. A design of a proposed combined wet-dry cooling tower is included. (JGB)

323 PREDICTION METHODS OF COOLING TOWER PLUMES: PARTS I--II. Junod, A. (Swiss Meteorological Inst., Payerne, Switzerland). pp 237-262 of Thermal effluent disposal from power generation. Zaric, Z.P. (ed.). Washington, DC; Hemisphere Publishing Corporation (1978).

From International advanced course on heat disposal from power generation; Dubrovnik, Yugoslavia (23 Aug 1976).

After reviewing briefly the possible meteorological effects of large heat discharges from cooling towers into the atmosphere, a systematic approach to modelling cooling tower plumes is presented, with particular emphasis on the limits and achievements of the different kinds of models: physical, conceptual, and hydrodynamic. Much attention is devoted to the proper definition of the meteorological data required as input for these models. Moreover the difficult problem of interpreting correctly models output with respect to the general climatological frame is subjected to discussion. The modelling and experimental studies conducted to assess quantitatively the meteorological effects of cooling towers showed that these effects have mostly a local character and that they are small to negligible when integrated over some longer periods of time (month, year). However, further research is needed, both on modelling techniques and experimental impact evaluation.

324 COOLING TOWER PLUME RESEARCH U.S. ENVIRONMENTAL PROTECTION AGENCY. Shirazi, M.A.; Tichenor, B.A. (Environmental Research Laboratory, Corvallis, OR). pp 263-282 of Thermal effluent disposal from power generation. Zaric, Z.P. (ed.). Washington, DC; Hemisphere Publishing Corporation (1978).

From International advanced course on heat disposal from power generation; Dubrovnik, Yugoslavia (23 Aug 1976).

A comprehensive review of EPA's cooling tower plume research program is provided with particular attention to plume modeling. The research began in 1969 with a modest effort to define the problem and continued through a multidisciplinary research project at a site where a single cell salt water cooling tower was installed to assess its impact on the local terrestrial ecosystem. The evolutionary process involving the analytical developments and advanced instrumentation techniques required for such undertaking is discussed. Plans for continued efforts are presented.

325 CALCULATION OF COOLING TOWER PLUMES WITH KUMULUS. Brog, P.E. (Motor-Columbus Consulting Engineers Inc., Baden, Switzerland). pp 283-292 of Thermal effluent disposal from power generation. Zaric, Z.P. (ed.). Washington, DC; Hemisphere Publishing Corporation (1978).

From International advanced course on heat disposal from power generation; Dubrovnik, Yugoslavia (23 Aug 1976).

The goal of the program KUMULUS is the evaluation of the primary nuisances due to cooling tower plumes in the power plant's vicinity. Among them one shall notice the visual impact, the loss of sunshine and luminosity, the water and salt precipitation downwind, the formation of fog, the danger of icing, the influence on the diffusion and settling of emissions from the chimneys of the plant. Up to 100 wet or drywet cooling towers or chimneys or diffusors, arbitrary disposition of the emissions sources and wind direction can be considered. The evaluation of the seasonal mean nuisances at the site is made using the KUMULUS's results for a few hundred meteorological (aerological) representative cases, their frequencies, the windroses and some others climatological weighting's factors. The results of this statistical approach for the meteorological influences at the site are i.e. a family of isolines for the seasonal water and salt precipiation downwind the tower, the seasonal loss of sunshine, the ground fogging (eventually using data from windtunnel measurements). The seasonal frequency of given discrete visual impact, of penetration of inversion layers, the duration and frequency of icing danger can be also be derived from the KUMULUS output and from the statistics. The program KUMULUS and its predecessor SAUNA-S have been used for preparing documents for electrical firms and authorities in

Switzerland, Federal Republic of Germany, and occasionally in Belgium. It was also needed to evaluate the modification of the cloud cover above a region with high concentration of power plants equipped with wet cooling towers.

326 BASIC CONCEPT OF A PREDICTION MODEL FOR THE COOLING TOWER PLUME. Egler, W.; Ernst, G. (Univ., Karlsruhe, Germany). pp 293-308 of Thermal effluent disposal from power generation. Zaric, Z.P. (ed.). Washington, DC; Hemisphere Publishing Corporation (1978).
From International advanced course on heat disposal from power generation; Dubrovnik, Yugoslavia (23 Aug 1976).
A set of equations describing the physical processes is presented. Modeling the three-dimensional turbulent motions of the plume is discussed. Special attention is payed to the production of turbulence by buoyancy forces. A simple way for calculating the water content distribution coupled with the enthalpy distribution is proposed. Finally, the model of the cooling tower plume is represented by a system of 17 differential equations.

327 HYDROTHERMAL MODELING TECHNIQUES ASSOCIATED WITH WASTE HEAT DISPOSAL. Harleman, D.R.F.; Jirka, G.H.; Stolzenbach, K.D. (Massachusetts Inst. of Tech., Cambridge, MA). pp 3-10 of Thermal effluent disposal from power generation. Zaric, Z.P. (ed.). Washington, DC; Hemisphere Publishing Corporation (1978).
From International advanced course on heat disposal from power generation; Dubrovnik, Yugoslavia (23 Aug 1976).
Techniques for estimating natural and induced water temperature variations associated with open cycle power plant condenser cooling systems are discussed as to the waste heat management and regulatory frameworks within which these techniques have found application in the United States.

328 THREE-DIMENSIONAL NUMERICAL MODEL FOR HYDROTHERMAL ANALYSIS OF COOLING PONDS. Vasiliev, O.F. (Institute of Hydrodynamics, Novosibirsk, USSR). pp 115-132 of Thermal effluent disposal from power generation. Zaric, Z.P. (ed.). Washington, DC; Hemisphere Publishing Corporation (1978).
From International advanced course on heat disposal from power generation; Dubrovnik, Yugoslavia (23 Aug 1976).
A brief analysis is made of the modern state of theoretical research of the hydrothermal behaviour of cooling ponds. Two mathematical models are suggested of unsteady hydrothermal processes in shallow water ponds taking into account the stratification in the Boussinesq approximation: one model with and the other without considering horizontal turbulent exchange. A method of numerical realization of the latter model is briefly described and some results of practical computations are reported.

329 UTILIZATION OF GEOTHERMAL COOLING WATERS FOR WASTE CONTAINMENT. Morrison, R.D. (SCS Engineers, Long Beach, CA). pp 469-470 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).
From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).
Geothermal power production utilizing a binary conversion process requires a substantial quantity of water for the cooling of the secondary or working fluid. Once this cooling water has left the condenser in such a system, it requires some form of process to lower its temperature. Several process alternatives are available: an evaporative dry cooling tower, a wet cooling tower, or a cooling lake. In those operations where a cooling lake is utilized or where large amounts of makeup water are stored, certain design parameters can be easily integrated into this cooling loop for the purpose of isolating geothermal or associated wastes. The necessary physical conditions and benefits of this arrangement are the subject of this paper.

330 COOLING WATER REQUIREMENTS FOR GEOTHERMAL POWER PLANTS AND WATER AVAILABILITY IN THE IMPERIAL VALLEY. Goldsmith, M. (Jet Propulsion Lab., Pasadena, CA). pp 215-218 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, California; Geothermal Resources Council (1978).
From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).
The cooling water requirements for geothermal power plants are calculated as a function of reservoir temperature and power plant type, and the availability of cooling water in the Imperial Valley of California is examined. First consider the cooling requirements for flash steam plants. Approximately, the rejection load is proportional to the steam rate. The first step is to determine steam rates for plants using steam of various temperatures.

331 CLIMATIC CONTROL WITH SOLAR ENERGY. Lessieur, P.D. (Compagnie Francaise des Petroles, Paris, France); Durand, J.P. pp 567-586 of Solar technology for building. Volume 2. Sessions 5 to 9. Stambolis, C. (ed.). London, England; RIBA Publications Ltd. (1978).
From International conference on solar building technology; London, UK (25 Jul 1977).
It is the purpose of this paper to describe the CFP-SOFRETES program for solar air conditioning in tropical climate. This description will be presented with some experimental data. This paper will examine the influence of the geometric situation of resistive and capacitive layers on the daily cooling load in air conditioned building. A program for calculating these characteristics has been set up and applied to the same building as an air conditioning example for hot-wet and hot-dry climate zones. An analysis is also made of the criteria used for selection of subsytems as cooling tower, automatic and storage tank. Then an experimental program was carried out with a test loop facility which was constructed to test the absorption machines and subsystems. Finally a special two temperature variable volume storage system, which limits the enthalpy degradation, was designed.

332 CLOSED-CIRCUIT COOLING IN A NUCLEAR POWER STATION WITH HIGH-TEMPERATURE REACTOR AND HELIUM TURBINE. Biele, B. BBC-Nachr.; 60: No. 5, 182-186(1978). (In German).
One of the special features of nuclear power stations with high-temperature reactor and helium turbine (HHT) is that dry closed-circuit cooling can be employed economically. The author presents the special features of the HHT-closed-circuit cooling system, using the 1240 MW plant as an example, and briefly describes the principle of operation and advantages of this power station.

333 MATSUKAWA GEOTHERMAL POWER PLANT-ENCOUNTER WITH ENERGY SAVING AGE. Shiga, S.

Seifutei Daijesuto; 24: No. 7, 241-245(1978). (In Japanese).

At the Matsukawa geothermal field where a 20,000 kW geothermal plant is in operation, six steam wells have been drilled so far at a total drilling cost of 1.2 hundred million yen. The electricity generated with the steam is sent to the Wakagawa factory of the Japan Metals and Chemicals Co., where the electrical smelting of manganese and ferrosilicon is carried out. The power is sold at a rate of 2.08 yen/kW, much cheaper than the power rate of 3.80 yen/kW of the Tohoku Electric Power Co. The operation of the plant is detailed. Steam coming from boreholes approximately 1000 m deep is sent to a separator provided with a pit head device, where dust, hot water and so forth are separated. The clean steam is then sent through a 2000 m major steam pipe to a steam storage area where it is again cleaned by a separator. It is then sent to a turbine at a pressure of 3.5 kg/cm^2, where the steam turns the 22,000 kW turbine to generate electricity by driving generators. The electricity thus generated is sent to a substation at a voltage of 11,000 V where the electricity is tranformed into a higher voltage of 154,000 V, and then transmitted to the Hachinohe main line of the Tohoku Electric Power Co. The steam heat which drove the turbine enters from the exhaust pipe onto a condenser where the steam is mixed with water. The hot water (approx. 45°C) produced at the condenser is sent to a large cooling tower 46 m high and 45 m in diameter, where the water is atomized and cooled water is returned to the condenser. Five figures and one table are provided.

334 OTHER IMPACTS. pp VI.1-VI.29 of Power plant cumulative environmental impact report. Annapolis, MD; Maryland Department of Natural Resources (1978).

Cooling towers can be an environmentally-acceptable alternative to once-through cooling. Basically, a cooling tower exchanges consumptive water use and possible terrestrial effects for effects in the aquatic environment. There also is a loss in energy production. Because the balance of these effects is site-specific, each plant location should be examined to determine the appropriate cooling system. Studies at Chalk Point indicate that salt deposition from the natural draft cooling tower would not exceed 8 kg/ha/month (7 lb/acre/month) at the maximum point. Experiments to determine the sensitivity of corn, soybeans, or tobacco indicated that no significant effects occurred at deposition rates below 20 kg/ha/month (18 lb/acre/month). The routing of transmission lines deals with effects that may have aesthetic, ecological, health and physical implications. The aesthetic effects generally include trade-offs between visibility and environmental protection. Ecological effects can be both positive and negative and must be evaluated on a case-by-case basis. The electrical effects are now well understood and are potentially significant only for locations within, or extremely close to the right of way. The health effects remain an area of controversy, mainly due to differing medical results from U.S. and Soviet studies.

335 STUDY OF COOLING POND FOG GENERATION. Leahey, D.M.; Davies, M.J.E.; Panek, L.A. (West Res and Dev, Calgary, Alberta). Proc. Air Pollut. Control Assoc.; 3: 1-13(1978).

The purpose of the study described was to evaluate the frequency which which fog might be expected to occur, the maximum distance over which the fog might create a visibility hazard and the rapidity with which the fog might be expected to dissipate. A time lapse camera was used to obtain a continuous observational record related to fog occurrence. Associated information was also collected concerning wind, potential temperature gradients, atmoshperic turbulence levls, and moisture deficits for purposes of testing a fog plume model. 4 refs.

336 EFFECTS OF EVAPORATIVE SALT WATER COOLING TOWERS ON SALT SPRAY AND SALT DEPOSITION ON SURROUNDING SOILS. Wiedenfeld, R.P. College Station, TX; Texas A and M Univ. (1978). 94p. University Microfilms Order No. 78-17,230.

Thesis (Ph. D.).

Five salt water cooling towers recently constructed near Galveston Bay, Texas were found to contribute to salt deposition in the surrounding area. Levels as high as 1200 kg salt/ha/yr were encountered within 100 m of the towers. Deposition rates decreased in a logarithmic fashion with distance to less than 300 kg salt/ha/yr at 434 m with only 16% attributable to the cooling towers. The remaining deposition was caused by natural sea spray which varys widely but averages about 250 kg salt/ha/yr in the study area. Changes in composition of air-borne salts with distance were noted, primarily as a narrowing of the Na:Ca ratio. The soils in the area adjacent to the salt water cooling towers had safe exchangeable Na and total salt levels. Changes in soil salinity due to the cooling towers after their first two years of operation were found only in the closest study plot at 104 m from the towers. A leaching study indicated that the various ions removed from the soil profile were in the same relative proportions as in the soil solution. Continued operation of the salt water cooling towers will eventually lead to relative cation concentrations in the soil solution equal to those in salts deposited from the cooling towers. Therefore, predictions based on cation-exchange equilibria indicate that exchangeable Na levels greater than 15% will be encountered as far away as 200 m from the cooling towers. This could lead to deterioration of soil physical structure, causing further reduction of the already slow internal drainage, thus enhancing salt accumulation problems. Because of the decrease in the Na:Ca ratio and the total amount of salt deposited with distance from the cooling towers, problems at greater distances will be lower and will require longer to develop.

337 AQUATIC IMPACT. pp III.1-III.36 of Power plant cumulative environmental impact report. Annapolis, MD; Maryland Department of Natural Resources (1978).

Because of the high reproduction rates of the plankton and good tidal mixing at existing plants, depletion of plankton populations has not occurred. Spawning occurs throughout the Bay for the species of fish present here, so local depletions are insufficient to decrease Bay populations. Impingement totals are small compared to mortality due to other sources. In addition, efforts to reduce these totals are now underway at all three existing plants, Calvert Cliffs, Morgantown, and Chalk Point. Habitat modification effects, usually more subtle in nature, have minor, localized impacts. Coupled together, the power plant monitoring studies show a low cumulative impact on the mesohaline environment. The major area of concern within this region is the impact of cooling water withdrawals upon the nursery and spawning areas of striped bass and other anadromous species. Possum Point and Vienna have the highest potential for impact. New facilities planned for this region (Douglas Point, Summit, and Vienna) would increase

withdrawals. The overall impact upon striped bass due to entrainment drops from an estimated 6.6% entrainment (upper bound) of the eggs and larvae spawned in the Maryland portion of the Bay at present to an estimated 3.4% (upper bound) after 1987. The addition of Douglas Point and Summit is more than off-set by the retirements of the once-through cooling units at Vienna. No impingement data are available at any of the present plants; however, degraded water quality at the Baltimore and Washington plants appears to have severely restricted fish populations in these waters. The proposed plants are expected to have no major impacts in the areas of impingement or habitat modification due to the small amount of water withdrawn.

338 PRIMER ON THE REJECTION OF WASTE HEAT FROM POWER PLANTS. CONSULTANT REPORT. Mitchell, R.D.; Horsak, R.D. Sacramento, CA; California Energy Resources Conservation and Development Commission (1978). 47p. (NP--23814).

Basic information is presented on why waste heat is rejectd from thermal power plants, the operation, optimization and evaluation of heat rejection systems, including cooling ponds and cooling towers, and the economic and environmental aspects of different cooling systems. (LCL)

339 EXAMINATION OF SOME AMBIENT PARTICULATE MONITORING TECHNIQUES USED FOR SITING AND ENVIRONMENTAL IMPACT ASSESSMENT OF BRACKISH WATER COOLING TOWERS. Wilber, K.R.; Moore, R.D. (Environ Syst Corp, Knoxville, Tenn). Proc. Air Pollut. Control Assoc.; 4: 1-22(1978).

The considerations associated with selection of proper instrumentation for assessment of baseline levels are discussed. Additionally discussed are the results of data from various sites acquired with various instrumentation under varying meteorological conditions. 16 refs.

340 DEVELOPMENT AND VERIFICATION OF A WET COOLING TOWER DRIFT DEPOSITION MODEL. Miksad, R.W.; Ratcliff, M.A. (Univ of Tex, Austin). Proc. Air Pollut. Control Assoc.; 4: 1-15(1978).

This paper presents the preliminary results of a model which is designed to predict drift deposition drop size distributions as well as number flux. The influence of evaporation and the drop breakaway process is investigated by using both a bulk breakaway criteria and a distributed partial breakaway criteria for each drop size. Comparisons are made at several downwind receptor sites for drop size distribution and number flux. 13 refs.

341 EXPLOITATION OF SOLAR ENERGY VIA MODULAR POWER PLANTS AND MULTIPLE UTILIZATION OF WASTE HEAT. Feustel, J.E.; Kraft, M. (M.A.N. Corp., Munich, West Germany). pp 1696-1700 of Sun: mankind's future source of energy. Volume Three. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

Described is the development of a solar farm plant designed on the modular system and having ratings of 15 to approximately 1000 kW. Such plants lend themselves particularly to decentralized supply of power in countries with high rates of direct insolation - roughly up to 40°N and S of the equator. An initial plant of 50 kW peak rating and 30 kW nominal rating also utilizing waste heat is presently being planned and built for a site in Almeria, southern Spain. Sections of the plant will be put into operation in 1978 and the plant will be in full operation by 1979. First tests and optimalization have been carried out at M.A.N.'s solar test center in Munich since 1976.

342 INTEGRATED OPTIMIZATION OF DRY VENTILATION COOLING TOWERS OF GAS TURBINE POWER PLANTS TAKING ACCOUNT OF OPERATING MODE FACTORS. Ponyatov, V.A.; Firsin, Yu.A. (Saratov Polytech Inst, USSR). Energomashinostroenie; No. 12, 41-43(1978). (In Russian).

An analytical method is considered permitting determination of the optimal flowrate of air and the number of columns in the dry cooling tower, taking account of operating mode factors. Results of calculation of the characteristics of a dry ventilation cooling tower for a gas turbine power plant with the capacity of 600 MW are presented.

343 SEISMIC RESPONSE OF A COLUMN-SUPPORTED COOLING TOWER. Gran, C.S. Lafayette, IN; Purdue Univ. (1978). 142p. University Microfilms Order No. 79-14,901.

Thesis (Ph. D.).

Hyperboloidal reinforced-concrete shells are modeled using orthotropic quadrilateral flat plate finite elements. The supporting columns and top ring beam are modeled by beam finite elements. Natural frequencies and corresponding mode shapes are found for several different tower configurations. Results for fixed-base shells are in close agreement with those determined using alternate methods of analysis. A cooling tower in the 1200 MW Fossil Fuel Steam Generating Power Plant at Paradise, Kentucky (Tennessee Valley Authority), is studied. Time-history responses of 30 seconds to the North-South acceleration component of the May 18, 1940, El Centro earthquake are computed by the technique of modal superposition. Only the modes with one circumferential wave are excitable by horizontal earthquake motion. A response spectrum analysis is used to ascertain the maximum response of the first three eccentric modes. From a RMS estimate of the total maximum response, forces and stresses in the shell and columns are obtained. The contribution of gravity loading is included. The effect of viscous damping is also considered. A high-order, doubly-curved membrane shell finite element is developed for application to the study of column-supported cooling towers. Element geometry, defined by lines of principal curvature, is restricted to shells of revolution but allows a third-order representation of the meridian. Element displacement assumptions are bicubic for the in-plane displacements and bilinear for the transverse displacement. The element stiffness matrix is partitioned by writing the mixed partial derivatives in terms of the rest of the degrees of freedom, thus forming an element with 28 degrees of freedom. Three rigid body modes are implicitly included in the formulation. Convergence characteristics are excellent as demonstrated by several examples, both static and dynamic.

344 SIMPLIFIED ANALYSIS OF SURFACE ENERGY EXCHANGE FROM HEATED BODIES OF WATER. Lorenzi, D.; Porter, R.W. (Illinois Inst. of Tech., Chicago). pp 93-101 of Advances in heat and mass transfer at air-water interfaces. Sengupta, S. New York, NY; American Society

of Mechanical Engineers (1978).

The nonlinear relationships of surface energy exchange coefficient and natural equilibrium temperature in terms of atmospheric conditions and water surface temperature are developed using the method of Ryan and Harleman but with adjusted aerodynamic coefficients for sensible and evaporative convection based on more recent studies. In a subsequent linearized approximate approach, following Ryan and Harleman, sensible and evaporative flux are computed seperately using dry-bulb and dew-point temperatures as respective driving potentials. Atmospheric radiation is linearized about that of a fixed reference temperature. In the present simplified approximate approach, sensible and evaporative flux are combined using the well-known analogy of heat and mass transfer which is quite valid for air and water-vapor mixtures. In this case, the wet-bulb temperature is the net driving potential for combined convective transport, and the formulas are somewhat simplified. A more exact treatment of atmospheric radiation is incorporated without additional complexity. Self-consistent computations were compared for a number of seasonal meteorological conditions and surface temperatures using the nonlinear and the two approximate methods. It is shown that the present simplified method generally gives a smaller and more consistent error than the previous linearized one, and for most purposes adequately represents the nonlinear case.

345 THIRD PARTIAL CONSTRUCTION PERMIT FOR PHILIPPSBURG NUCLEAR POWER PLANT UNIT 2 OF OCT. 19, 1978. GRS Kurz-Inf., Reihe C; 44: No. 45, 1-2(1978). (In German).

The permit covers the erection of the cooling tower structure including the cooling tower basis, the water intake canal with climbing shafts and distribution troughs, the supporting panels for the cooling-tower fills, all construction-dependent detachable accessories like reeds and tie plates as well as the ground drainage systems. Issuing this Third Partial Construction Permit will establish no right on the issuance of further permits or licenses.

346 DRY COOLING FOR POWER STATIONS. Forgo, L. pp vp of Joint power generation conference. New York, NY; Inst. of Electrical and Electronics Engineers (1978).

From ASME conference on power generation; Dallas, TX, USA (10 Sep 1978).

As growing interest is shown in indirect dry cooling plants for power stations, experiences gained in such plants having been in operation for 6-17 years are summarized. Only a few important questions are dealt with, such as materials and corrosion of heat exchangers, mechanical and natural draft, wind effect and cooler arrangement, direct contact and surface condensers.

347 OPTIMAL DESIGN OF WET COOLING TOWER/ONCE-THROUGH HYBRID COOLING SYSTEMS. Hsu, T.D. Iowa City, IA; Univ. of Iowa (1978). 167p. University Microfilms Order No. 79-12,858.

Thesis (Ph. D.).

A comprehensive computer model has been developed for the analysis of water consumption, thermodynamics, and optimum design of wet cooling tower/once-through hybrid cooling systems. The main idea of this study is to use permissible river heat assimilation capacity as much as possible. Wet cooling towers are used as helper systems with once-through cooling at sites which have extensive but still inadequate once-through cooling capacity. The computer model allows studying the once-through, closed-cycle, and three types of hybrid cooling systems. The model gives all the required information for selection of a system such as optimum tower size, design cooling range, design turbine back pressure, condenser temperature rise, capacity and energy loss, evaporation water loss, capital cost, operating cost, and total cost. Simulation studies have been made for three sites along the Missouri River. For the conditions studied, the results identify that the hybrid cooling system arranged in a series water-path with a partially closed-cycle loop (referred to as Type 3) appears to be the most attractive. Comparison of once-through cooling with all hybrid cooling systems indicates that the latter are economically superior but have higher water consumption. Finally, it was found that combination wet tower/once-through cooling systems are economical and have less evaporative water loss than closed-cycle wet tower cooling systems.

348 OPTIMUM COMBINATION OF SELECTED COOLING ALTERNATIVES FOR ELECTRIC POWER PLANTS. Lee, R.M.H. Iowa City, IA; Univ. of Iowa (1978). 158p. University Microfilms Order No. 79-12,876.

Thesis (Ph. D.).

An overview of cooling alternatives for power plants, qualitative aspects of environmental impacts of these systems, and detailed thermodynamic and economic analyses of various cooling systems are presented. Major emphasis is placed on the examination of several wet tower/cooling pond combination cooling systems with computer models. The models are used to study the thermal characteristics, economics, and water consumption aspects of these cooling systems. The economic analysis identifies the optimum (minimum cost) cooling system which is based on considerations of capital costs and annual operating costs amortized over a realistic operation horizon. The effects of both configuration and economic parameters, such as various unit costs, on the economic and thermodynamic performance of the cooling system are examined. Los Angeles, California, is used in case studies to illustrate the most promising cooling system configuration with regard to its economic or water conservation aspects. It is found that the parallel water path configurations of the wet tower/cooling pond combination cooling system are economically superior to the series water path configurations. Considering the temperature distribution in the pond, the thermodynamic and economic performance of the combination system with a slug-flow pond is much better than that of the combination with a fully-mixed pond. Variations of the unit costs of water (as well as fuel) obviously affect total cost but have only secondary effects on the determination of the optimum mode of operation. Comparison of the dry/wet tower system with the wet tower/cooling pond system indicates that the latter is economically superior but has higher water consumption.

349 BRACKISH GROUNDWATER FOR POWER PLANT COOLING IN CALIFORNIA. Scott, V.H.; Scalmanini, J.C.; Popko, K.A. Sacramento, CA; California Energy Resources Conservation and Development Commission (1978). 116p. (NP-23928). University of California, Dept. of Land, Air and Water Resources, Davis, CA.

An investigation which assessed the potential use of brackish groundwater in California as cooling water for thermal power plants is reported. Information is included on

California groundwater resources; the occurrence of brackish groundwater basins; characteristics of these basins; technical, economic, legal, and environmental aspects of proposed use of brackish groundwater; how to confirm the groundwater supplies; and assessment of brackish groundwater near a Yuba County power plant site. (LCL)

350 STUDY OF HEAT TRANSFER PROCESSES ABOVE A COOLING POND. Hicks, E.B.; Wesley, M.L.; Sheih, C.M. (Argonne National Lab., IL). Water Resour. Res.; 13: No. 6, 901-908(Dec 1977).

Rapid-response instrumentation mounted on a fixed tower located centrally in a strongly heated cooling pond at a nuclear power facility has enabled evaluation of the turbulent fluxes of momentum, moisture, and sensible heat. The results agree well with evaluations based on stability-corrected bulk aerodynamic formulations, provided all atmospheric measurements are made close to the water surface and in a location with adequate upwind fetch. The bulk formulae are those that have been verified recently over more extensive water surfaces, with a minor modification based on the finding that the surface of the cooling pond appears to be significantly smoother than that of open ocean.

351 TRICKLE PLATE FOR COOLING TOWERS. Henning, H.; Kliemann, S. (to Balcke-Duerr A.G., Ratingen (Germany, F.R.)). German(FRG) Patent 2,615,407/A/. 17 Nov 1977. 15p. (In German).

It is proposed that the trickle plate for cooling towers should be modified so that it is made at both sides at the lower edge as a water collecting gutter. Such a trickle plate is suitable for counter flow and for transverse flow construction. Variations of shape and of the collecting gutter are described.

352 CONTRIBUTION TO THE CALCULATION OF DIRECT WATER-TO-AIR HEAT EXCHANGERS, I.E. WITHOUT PARTITIONS. Merigoux, J. (Centre Technique des Industries Aerauliques et Thermiques (CETIAT), 69 - Lyon (France)). Klima Kaelte Ing.; 5: No. 11, 385-388(Nov 1977). (In German).

Two methods are presented, how to determine the heat and mass transfer coefficients in air-water heat exchangers: iterative integration of the heat transfer rate, use of the log mean enthalpy difference.

353 COOLANT CIRCUIT FOR A POWER STATION AND PROCESS FOR OPERATING COOLANT CIRCUIT. Morse, D.C.; Vrable, D.L.; Potthoff, R.E.; Fay, H.P. (to General Atomic Co., San Diego, Calif. (USA)). German(FRG) Patent 2,711,287/A/. 22 Sep 1977. 25p. (In German).

This is concerned with the compensation of the cooling capacity which is reduced by day compared to night operation, e.g. a dry cooling tower, with the aim of better overall use and a day cooling capacity which can be increased, i.e. power station output delivered can also be increased. This is achieved by storage of excessive cooling capacity at night in a water store, which is switched into the normal cooling circuit in the form of a large basin. The night excess of cooling capacity is applied to the water in the store in the form of lower cooling water temperatures. While with fully used capacity of the cooling tower during the day, cooling water at higher temperature than at night is fed into the store, sub-cooled water can be taken from the store. The higher cooling performance means higher power station output.

354 (DOE-tr--189) WASTE HEAT PROJECT - UPPER RHINE AREA. FIRST SEMIANNUAL REPORT, 1977. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Lab. fuer Aerosolphysik und Filtertechnik 1). Aug 1977. Translation source information not available 97p. Dep. NTIS, PC A05/MF A01.

The waste heat project for the Upper Rhine area was initiated in order to analyze the relationships between weather phenomena and heat emissions, and in order to draw conclusions from this for planning purposes. It consists of the following component projects: Component Project 1 - setting up a waste heat register for the Upper Rhine area; Component Project 2 - climatological and small-scale aerological studies in the Upper Rhine area; Component Project 3 - analysis of climatological fluctuations for the Upper Rhine area; Component Project 4 - meteorological simulation models; and Component Project 5 - estimate of consequences of waste heat emission in the Upper Rhine area. Special emphasis is placed on the methods of analysis, measurement, model theory, and estimation of consequences, some of which are already being applied and some still to be developed.

355 COOLING TOWER. Jasch, E.; Schardt, R. (to Krupp (Friedr.) G.m.b.H., Essen (Germany, F.R.)). German(FRG) Patent 2,602,058/A/. 28 Jul 1977. 11p. (In German).

In a dry cooling tower, the main surfaces of the large upwards channel are formed by a flexible cover, which is tensioned over a cable net in the form of a hyperboloid. The cable net hangs from an upper ring supported by cables from the top of the mast, has a distance ring of somewhat smaller diameter at about half its height and ends in a lower ring of somewhat greater diameter (than the higher one). From this closing ring at the lower end of the actual cooling tower, the surfaces of the cooling elements extend with a slight inclination to the inside and downwards. They end at a lower circle on the central mast. The cooling elements, according to the invention, are connected via bellows and mechanically solidly to the closing ring. Damaging outside air cannot flow in there. With a conically spread foot of the mast and suitable shaping of the cooling elements, these can be positioned freely between the foot of the mast and the closing ring, and expensive support frames and vertical supports can be saved. Also, cables acting as spokes between the closing ring and the foot of the mast take load from the cooling elements and stabilise the closing ring. As the cable net with the flexible cover is pretensioned by the weight of the closing ring, some cables of the cable net extended downwards with light floor anchoring are sufficient for further load relief. The foundations of the mast have a lower vertical load due to these relatively low load relief forces and the load reduction from the closing ring to the foot of the mast.

356 EVAPORATION HEAT EXCHANGER. Niemens, W. German(FRG) Patent 2,558,969/A/. 7 Jul 1977. 11p. (In German).

This principle of a heat exchanger should combine the advantages of the dry cooling tower (closed circuit) with the advantages of the wet cooling tower (intensive heat removal by evaporation) by the interposition of a third medium between the coolant circuit and the cooling air. For this purpose, the heat

exchanger tubes which have cooling water flowing through them as the primary medium are equipped with annular discs as cooling ribs at equal spacing. The intermediate spaces between these ribs are filled with porous, heat conducting rings, so that the heat exchanger tube with the ribs and rings form a full cylinder. These rings are fed with water, as an intermediate medium to be evaporated via a pipe line of low diameter taken along the internal wall of the heat exchanger tube or outside. A liquid/gas interface is formed in the ring or evaporation body under the influence of the cooling air flowing past (as the second medium), from which the water intermediate medium is evaporated, taking away the heat. The heat exchanger according to the invention should be considered specially for cooling plant and should save investment and running costs. The cooling tower circuit as liquifier of a refrigeration plant can be omitted. For operation in parallel or in series with a refrigeration plant, its operating time should be restricted or (in special cases) the refrigeration plant can be dispensed with altogether.

357 EQUIPMENT TO SEPARATE LIQUID DROPLETS FROM THE COOLING AIR STREAM OF A LIQUID COOLING TOWER. Thompson, S.E.; Schwinn, J.M. (to Ecodyne Corp., Lincolnshire, Ill. (USA)). German(FRG) Patent 2,658,550/A/. 7 Jul 1977. 13p. (In German).

In order to separate off liquid droplets from the air stream of a cooling tower, one uses separator blades that are secured to the supporting construction. An improvement on this is proposed to make the repairs easier. According to the invention, the separator blades should be fabricated from springy material with self-supporting strength and can be fitted onto the supporting construction by means of slits and notches.

358 VALVES FOR CONDENSER-COOLING-WATER CIRCULATING PIPING IN THERMAL POWER STATION AND NUCLEAR POWER STATION. Kondo, S. (Nippon Valve Mfg. Co. Ltd., Tokyo). Karyoku Genshiryoku Hatsuden; 28: No. 7, 663-672(Jul 1977). (In Japanese).

Sea water is mostly used as condenser cooling water in thermal and nuclear power stations in Japan. The quantity of cooling water is 6 to 7 t/sec per 100,000 kW output in nuclear power stations, and 3 to 4 t/sec in thermal power stations. The pipe diameter is 900 to 2,700 mm for the power output of 75,000 to 1,100,000 kW. The valves used are mostly butterfly valves, and the reliability, economy and maintainability must be examined sufficiently because of their important role. The construction, number and arrangement of the valves around a condenser are different according to the types of a turbine and the condenser and reverse flow washing method. Three types are illustrated. The valves for sea water are subjected to the electrochemical corrosion due to sea water, the local corrosion due to stagnant water, the fouling by marine organisms, the cavitation due to valve operation, and the erosion by earth and sand. The fundamental construction, use and features of butterfly valves are described. The cases of the failure and repair of the valves after their delivery are shown, and they are the corrosion of valve bodies and valve seats, and the separation of coating and lining. The newly developed butterfly valve with overall water-tight rubber lining is introduced.

359 METHOD AND DEVICE FOR CLEANING SYNTHESIS GAS. Vollhardt, F. (to SAG Siegener A.G.). German(FRG) Patent 2,556,370/A/. 23 Jun 1977. 11p. (In German).

The slag-containing hot synthesis gas produced during coal gasification is purified by coolant injection into the pipe axis in parallel flow or counterflow. The constructive feature of the unit, which consists of slag collector tank, heat exchanger, and gas lines, is the variable position of the coolant supply lines.

360 EFFICIENCY AND UTILIZATION OF COOLING TOWERS. Rogers, P. US Patent 4,031,373. 21 Jun 1977. Filed date 25 Mar 1976. 6p.

The invention relates to cooling towers of the type currently in use for cooling water and/or condensing exhaust steam as for example in association with nuclear or fossil fuel type power plants. Typically towers are very large and very high. The invention embodies an original concept for utilization of such towers, for example hyperbolic towers, for the generation of energy from wind and also for improving the efficiency of the cooling tower. In the exemplary form of the invention a large wind driven rotor is provided to be carried by the tower and to rotate around its axis at the position of the narrowed throat of the tower. Pressure is generated by the rotor and discharged through nozzles arrayed on the inside of the walls of the tower to augment and enhance the draft within the tower.

361 METHOD TO REMOVE THE WASTE HEAT FROM THE COOLING CIRCUIT OF INDUSTRIAL PLANTS. Wieser, R. (to Hochtemperatur-Reaktorbau G.m.b.H., Koeln (Germany, F.R.)). German(FRG) Patent 2,550,908/A/. 18 May 1977. 9p. (In German).

Improving present cooling methods in order to lower the temperature in the cooling circuit of an industrial plant and thus to increase the efficiency of the plant are described. This is achieved by removing part of the heat with the aid of fresh water led through a heat exchanger on the secondary side which is connected in series with the dry cooling tower in the cooling circuit. The fresh water is cooled in a wet cooling tower.

362 NATURAL-DRAUGHT DRY COOLING TOWER FOR STEAM POWER PLANTS. Nasser, G.E.D. (to Linde A.G., Wiesbaden (Germany, F.R.)). German(FRG) Patent 2,454,055/C/. 21 Apr 1977. 5p. (In German).

The problem of making natural-draught cooling towers for large steam power plants as simple, compact, and economical as possible can be solved by a combination of well-known structural features: The condenser elements, which are designed as stacks of plates with corrugated surfaces, are arranged in the form of a truncated pyramid enlarged at the top. In the cooling air flow, there are openings for feeding in superheated gas from the lower part of the cupola.

363 COOLING TOWER WITH FORCED CONVECTION. Kelp, F. (to Kraftwerk Union A.G., Muelheim an der Ruhr (Germany, F.R.)). German(FRG) Patent 2,250,071/C/. 31 Mar 1977. 4p. (In German).

Using air or magnetic cushions and linear motor drives, frictional losses as well as noise and wear are reduced, so that a blower of large mass can rotate economically and with high efficiency at the point where the cooling tower diameter is largest. This blower at the basis of the cooling tower consists of an

endless blade row between two rotating ring elements of cooling tower diameter.

364 (ANL-Trans--1146, pp 1-15) CONCERNING THE THERMAL LOAD ON THE ATMOSPHERE ESPECIALLY FROM POWER STATION PARKS. Fortak, H. Mar 1977. Translation of Colloquium on location problems in the planning of power stations, Dusseldorf, 1976, Paper 1.

From Colloquium on location problems in the planning of power stations; Dusseldorf, F.R. Germany (1 Oct 1976).

Minister for work, health, and social questions of the North Rhein-Westphalen District: removal of cooling tower heat from power stations. A contribution to the discussion of location problems in the planning of power stations and power station parks.

A diagram is developed and described which relates the influence of power station clusters to atmospheric phenomena in terms of energy, and, to a certain extent, also dynamically. Since, at present, no power station clusters exist, no empirical knowledge is available about meteorological and climatological effects to be expected from such clusters, and empirically verified theoretical predictions of the effects are also not possible. A diagram is shown that gives the emitted thermal capacity, the basic emission area for natural and anthropogenic thermal sources, and the associated specific vertical energy flow. Characteristic values for the thermal buoyancy and the associated vertical velocity at representative altitudes above the emission areas are calculated. With respect to the arrangement of cooling towers over an area, it appears that from the standpoint of environmental protection, it is more favorable to avoid clusterings of cooling towers in small areas, and instead of this, to aim at a design in which smaller power stations are spread over the area.

365 HEAT EXCHANGERS. Roetzel, W. (Hochschule der Bundeswehr, Hamburg (Germany, F.R.). Inst. fuer Mechanik und Thermodynamik). Fortschr. Verfahrenstech.; No. 15, 161-174(1977). (In German).

More than 110 publications of the years 1975 and 1976 on the subject of 'Heat exchangers' are reviewed. The following has been included: books and reviews, calculation methods for heat exchangers without phase changes, investigations of fin-tube heat exchangers and special constructions, calculation methods for condensers and evaporators, cooling towers and direct heat exchangers.

366 STUDY OF A FLUIDIZED TURBULENT BED CONTACTOR WITH APPLICATION TO COOLING TOWERS. Dengler, J.L. Lafayette, IN; Purdue Univ. (1977). 279p. University Microfilms Order No. 78-03,215.

Thesis (Ph. D.).

A turbulent bed cooling tower was studied in which hot water enters the top of the column and falls by gravity while countercurrently contacting an upward flowing air stream which causes evaporative cooling of the water. Low density fill material is fluidized by the passing streams and is maintained in a state of agitation. This turbulence produces transfer rates much higher than in conventional fixed-bed towers thereby reducing capital cost by reducing equipment size and reducing the cost required for air moving. The turbulent bed contactor is versatile in that the fill type or depth is easily altered to change performance and operating cost. Operating variables were studied and experimental innovations made in order to maximize cooling performance. The operating variables studied were liquid flow rate, liquid to gas flow ratio, static fill depth, hot water temperature, and ambient wet bulb temperature. Eleven fill materials were tested with respect to fluidization, and seven were further evaluated in cooling tests. Staging the fill in layers was attempted to overcome the inherent disadvantage of axial mixing.

367 FAN ENERGY COSTS IN COOLING TOWERS. Schnell, H. (Sulzer-Escher Wyss G.m.b.H., Lindau (Germany, F.R.)). Tech. Bau; No. 3, 285-287(1977). (In German).

In cooling water circuits with optimum dimensions, mechanical-draught cooling towers are the only way to reduce energy costs. Rational cooling tower design depends on an exact knowledge of the climatic conditions at the site. As the cold-water temperature varies with the ambient air, a bypass line is necessary, or pole-changing motors are used, so that the temperature will not fall below a certain limit. For a careful selection of the necessary technical data, 6 calculation examples are given with variable operating conditions, climatic conditions, and different utilisation of the operating behaviour.

368 DISCHARGES FROM NUCLEAR POWER STATIONS. ENERGY VALUE OF LOW-TEMPERATURE WATER. Dumont, M. (CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Dept. de Transfert et Conversion d'Energie). pp 191-196 of Urban district heating using nuclear heat. Vienna; International Atomic Energy Agency (1977). (In French)

From IAEA committee on use of nuclear heat for urban heating; Vienna, Austria (15 Mar 1976).

Nuclear power stations discharge vast quantities of water at temperatures of 12K or 23K above that of the intake, depending on whether they are of the open-circuit type or use cooling towers. By choosing the energy value of the discharged water as parameter, it is possible to determine quickly whether a project offers economic possibilities for district heating or for supplying heat to agricultural zones. The author presents a preliminary study which could be used as a basis for a model optimizing the distance, the requirements and the applications. The initial conclusions show that there is little economic advantage to be gained from utilizing the heat contained in the water from open-circuit power stations with a temperature 12K higher than the intake. For power stations operating with cooling towers (water 23K above intake temperature) district heating is feasible if the town is less than 30km from the power station. Otherwise it is only economic to use the heat for agricultural purposes, provided that the area to be supplied is less than 10km from the power station. No account is taken here of ecological conditions which could affect these results.

369 PROBLEMS OF DESIGNING COOLING CIRCUITS. Rossini, R. (Ente Nazionale per l'Energia Elettrica, Milan (Italy)). Bull. Dir. Etud. Rech., Ser. A; No. 2, 313-334(1977). (In Italian).

From 3. Meeting on water column separation; Royaumont, France (23 - 26 May 1976).

The study of the phenomena related to liquid column separation becomes more and more interesting with regard to the design of the large hydraulic cooling circuits of thermal and nuclear power stations: it is necessary, on the

one hand, to reach an ever better understanding of the phenomena themselves, and, on the other, to develop a mathematical model which can simulate the transient regime of the plant during the design phase, in order to clarify its possible drawbacks and help in the elaboration of the most adequate control system.

370 INDUSTRIAL BUILDINGS ENERGY MANAGEMENT. Gilson, P. (US ERDA). SME Tech. Pap., Ser. EM; No. EM77-291, 1-10(1977).

This paper discusses measures for achieving savings in energy demand for building operation which are possible within the present state-of-the-art with accepted principles and commercially available devices. These measures are not the usual conservation practices already adopted for operation of most commercial industrial facilities. Rather, the recommendations involve improvements in the design and operation of air conditioning, heating and ventilation and materials handling equipment.

371 ECOLOGICAL INVESTIGATION OF HUDSON RIVER MACROZOOPLANKTON IN THE VICINITY OF A NUCLEAR POWER PLANT. Ginn, T.C. New York; New York Univ. (1977). 292p. University Microfilms Order No. 78-03,091.

Thesis (Ph. D.).

Studies were conducted on selected Hudson River macrozoplankton species to determine temporal and spatial distributions and responses to power plant operation. Distinguishing morphological and habitat characteristics were determined for the three gammarid amphipods (Gammarus daiberi, G. tigrinus, and G. fasciatus) occurring in the Hudson River. The oedicerotid amphipod Monoculodes edwardsi and the mysid Neomysis americana, in addition to the gammarid amphipods, displayed characteristic diel and seasonal abundances which affect their potential availability for power plant entrainment. The selected macrozooplankton species were utilized in temperature and chlorine bioassays in order to predict responses to cooling water entrainment. Although amphipods (Gammarus spp. and M. edwardsi) survived typical Indian Point cooling water temperatures, N. americana had high mortalities during a 30-minute, 8.3°C ΔT at 25°C ambient temperature. The bioassay results were substantiated by generally high survivals of entrained amphipods at the Indian Point plant. Neomysis americana were more heat sensitive, as indicated in bioassays, with average entrainment mortalities ranging from 30 to 60 percent during the summer. All species examined had higher immediate and latent mortalities during plant condenser chlorination. The ability of Gammarus to survive condenser passage and exposure to the Indian Point thermal discharge plume indicates that power plant operation on the lower Hudson River Estuary has no adverse impact on local gammarid amphipod populations. Entrained N. americana experience considerable mortalities; however, the impact on Atlantic Coast populations is minimized by the limited exposure of the population fringe to the Indian Point power plant.

372 PREVIEW CONTROL APPLIED TO COOLING SYSTEMS OF POWER PLANTS. Gunewardana, D.R. Berkeley, CA; Univ. of California (1977). 113p. University Microfilms Order No. 78-12,582.

Thesis (Ph. D.).

The application of dynamic control to cooling systems of power plants, with particular reference to preview control, is studied. The cooling systems considered are of the combined type that have more than one form of cooling. From a control viewpoint such systems can be considered to be multi-mode dynamical systems whose dynamics change depending upon the mode of operation. The performance of all cooling systems depends mainly upon the ambient conditions and the heat load applied. The nonlinear nature of the problem sets it apart from the preview control problems dealt with in the literature thus far. The problem is no longer analytically tractable. An algorithm based on a preview control model that makes use of the iterated determination of optimal trajectories is developed. The feedback control problem for the cooling system is considered to be a special case of the preview control problem, i.e., with zero preview, since this idea provides, perhaps, the most convenient and best solution. The preview control algorithm is applied to two cooling systems; one consisting of a wet cooling tower and a fixed pipe spray pond and the other consisting of a dry cooling tower and a fixed pipe spray pond. The evaporative portions of the cooling systems are modelled using information from the Rancho Seco power plant at Sacramento and experimental data from the University of California, Richmond Field Station. Significant savings in cooling cost are indicated with the use of dynamic control.

373 THERMAL REGIMES OF UPPER MISSISSIPPI AND MISSOURI RIVERS AND HYBRID ONCE-THROUGH WET TOWER COOLING SYSTEMS FOR POWER PLANTS. Su, T.Y. Iowa City, IA; Univ. of Iowa (1977). 342p. University Microfilms Order No. 77-21,175.

Thesis (Ph. D.).

A steady-state version of the Iowa Thermal Regime Model (ITRM), hereinafter referred to as the SSM, is developed for use in predicting river-temperature distributions for steady hydrological, meteorological, and thermal-input conditions. In addition, a Linear Steady-State Model (LSSM) is formulated to yield, by superposition, solutions for river-temperature distribution. The results of the temperature distributions obtained from the SSM and LSSM are in very good agreement with those given by the ITRM. Therefore, the comparatively simple SSM or LSSM should be used to predict the river thermal regimes if transient solutions are not of interest. Hybrid once-through--wet tower cooling systems are recommended for use in power plants at sites where the remaining river heat-assimilation capacity is extensive but not adequate during certain periods. Two configurations are investigated extensively: the open-cycle parallel arrangement (OC Model), and the partially closed-cycle parallel arrangement (PCC Model). The total cooling related costs of unit energy production for the hybrid once-through--wet tower and simply once-through cooling modes are calculated and compared.

374 COOLING TOWER MONEY MAKING SUPERSTAR. Burger, R. (Robert Burger Assoc Inc, New York, NY). pp 165-182 of 6th proceeding of the environmental science conference. Louisville, KY; Univ. of Louisville (1977).

From 6. environmental engineering science conference; Louisville, KY, USA (28 Feb 1977).

The paper discusses upgrading cooling towers for greater energy efficiency, and maintenance of the most prevalent types of modern cooling towers in use today. It is concerned primarily with the counter-flow cooling towers, and cross-flow cooling towers, but hyperbolic towers are

noted. Two examples are presented. On one, an owner saved $125,000 by expanding an existing installation by 3000 gpm rather than adding new towers; other savings amounted to $11,914.15 in electrical costs plus and energy conservation of 1675.7 KWH/yr. The other example involved energy saving of 837.8 KWH/yr and $40,000.00 of new construction costs which were not required.

375 FINITE ELEMENT INSTABILITY ANALYSIS OF HYPERBOLIC COOLING TOWERS. Mang, H. (University of Vienna, Austria); Gallagher, R.H.; Cedolin, L.; Schwinden, W.D. pp 246-249 of Advances in civil engineering through engineering mechanics. New York, NY; American Society of Civil Engineers (1977).

From ASCE engineering mechanics division specialty conference; Raleigh, NC, USA (25 May 1977).

Hyperbolic cooling towers are among the most dramatic of man-made structures on account of their considerable size. The structural designer views these structures with some caution due to the failures which have taken place, such as those which occurred under the action of wind at Ferrybridge, England in 1965 and at Ardeer, Scotland, in 1973. Although the precise mode of failure in these cases is unknown, many believe it was due to elastic instability under wind action. Thus, an estimation of structural integrity with respect to elastic instability under wind loads must be an integral part of any hyperbolic cooling tower design exercise. An approach and related computer programs that have been developed for this purpose are described.

376 ONE COOLING TOWER INSTEAD OF THREE. Rowe, F.D. (SKF Ltd., Luton (UK)). Kugellager-Z.; 51: No. 190, 23-25(1977). (In German).

Large power plants normally need several cooling towers which are more than 100 m high. In order to keep the environmental influence as low as possible, a new-kind cooling tower was developed in England the efficiency of which equals to that of 3 conventional cooling towers. The 114 m high cooling tower with a foot diameter of 91,4 m has, around the tower foot, a 'cooling zone' consisting of 35 individual cells each of which is equipped with an axial ventilator. The air sucked in by the ventilator cools the water perculating in the cell and flows then out through the tower. Thus the back-cooling does not take place in the tower.

377 COOLING WATER SYSTEMS - ENERGY CONSERVATION THROUGH SELECTIVE INHIBITOR PROGRAMS AND OPERATING TECHNIQUES. Puckorius, P.R. (P. R. Puckorius and Associates, Cleveland, OH). pp 10p, Paper 69 of Corrosion/77. The International Corrosion Forum devoted exclusively to the protection and performance of materials. Houston, TX; National Association of Corrosion Engineers (1977).

From Corrosion/77 NACE meeting; San Francisco, CA, USA (14 Mar 1977).

Cooling water systems offer opportunities to provide considerable energy savings. Some of these possibilities, how they can be instituted, and the savings that can be obtained are reviewed.

378 DIFFERENT TYPES OF COOLING TOWERS INFLUENCE THE DESIGN AND THE CONDITIONS OF THE INLET OF COOLING WATER PUMPS. Migod, A.; Siekmann, H. KSB Tech. Ber.; No. 17, 25-45(1977). (In German).

Possible solutions of performance and number of cooling water pumps to be installed for 300 mw conventional to 2000 mw nuclear unit powers are shown. As four influencing parameters greatly vary, each pump is individually manufactured. The specific fast-running pumps are sensitive to disturbances on the suction side. 11 examples for the useful shape of chambers and arched beams of the inlet building are given according to their importance. Characteristic and proved inlet chamber types were determined by electron-analog tests and model tests. What one understands by non-destructive flow to the pumps, is determined by means of four criteria, e.g. cavitation and NPSH value (net positive suction head) or according to DIN 'Haltedruckhoehe'. As all four criteria cannot be fulfilled to a maximum, one must be able to decide between them. The constructions of cooling water pumps, pipe and spiral casing with variation are treated in nine examples. Finally, the types of control are discussed. Construction and fabrication of a single cooling pump for a 1300 mw unit would be possible today; pressure joints diameter 4500 mm.

379 EFFECT OF CIVIL ENGINEERING AND ACCESS CONDITIONS ON THE COOLING WATER PUMPS AND THE VARIOUS TYPES OF COOLING WATER PUMPS FOR COOLING TOWERS. Holzhueter, E.; Migod, A.; Siekmann, H. (Klein, Schanzlin und Becker A.G., Frankenthal (Germany, F.R.)). Kaelte Klimatech.; 30: No. 7, 258-264(1977). (In German).

Starting with the pump inlet construction one can see that the designer must decide early on between the acceleration bend and the inlet chamber. To achieve smooth flow, four main conditions must be largely fulfilled. The rotor of cooling tower pumps is usually of the semiaxial type, where one must distinguish between non-adjustable, settable and adjustable rotors. The cooling tower pumps for drain and recirculation cooling are preferably made as spiral casing pumps. For nominal sizes of 2600 and larger, the pump casings are made of concrete, for economic reasons. For combined cooling, the type of pipe casing is decided for the same reasons. The above nominal size limit again decides a conrete design. Of the well-known control processes, the pre-rotor and rotor blade adjustment are at present the most economical. Both types of control are compared.

380 WATER REUSE STUDIES. Washington, DC; American Petroleum Institute (1977). 127p. $3.00.

Methodology for the reduction or elimination of refinery wastewater discharges were developed and key processes demonstrated in pilot plants. The approaches developed are primarily directed toward use in grass roots refineries. Segregation of wastewater streams was limited to (1) high-quality streams suitable with minimum treatment for use in steam generation; (2) relatively low TDS streams which, with minor treatment, are suitable for use in cooling; and (3) high TDS streams to be treated for the removal of characteristic refinery contaminants and reduced in volume or reduced to solid form for ultimate disposal. Because the preponderance of the water used in the model 150,000 barrels per day integrated refinery was for utilities (that is, cooling and steam generation), major emphasis was given to water management practices in these areas of use. As a result of the utilities water management practices and the reuse of various waters in processes, such as stripped sour water for desalting, the total effluent requiring final treatment was reduced primarily to the contribution of desalting effluent, ballast water, water treatment plant

regenerants, and some process wastewater. The combined flow of these streams amounted to 22% of the normal wastewater volume. The final methodology for treating the reduced volume of high TDS effluent was a sequence of oil removal, equalization, solids removal and bio-oxidation, followed by a coil shed cooling tower which accomplished further reductions in wastewater volume utilizing waste heat. The blowdown from the cooling tower flowed to a brine concentrator where a final reduction in volume produced an effluent slurry for disposal and high-quality distillate water for use as boiler feedwater.

381 CONSIDERATIONS AND CALCULATIONS ON THE NECESSITY OF MAKE-UP WATER IN THE COOLING TOWER OF A GEOTHERMAL ELECTRIC POWER PLANT. Zancani, C. (Electroconsult, Milan, Italy). pp 697-719 of International symposium on geothermal energy in Latin America. Rome, Italy; Instituto Italo-Latinoamericano (1977). (In Spanish)

From Geothermal conference; Guatemala City, Guatemala (18 Oct 1976).

After an illustration of the method of graphic calculation to establish the state of the atmosphere at the output of the cooling tower and consequently the loss of water by evaporation, it is concluded that theoretically there is no necessity for make-up water other than the condensed geothermal steam. Some discussion is given on the chemical-physical phenomena accompanying the cooling process.

382 COOLING TOWER ENVIRONMENTAL IMPACT PREDICTION IN THE CASE OF NUCLEAR POWER PLANT MIXED COOLING SYSTEM. Vehauc, A.; Zaric, Z. (Institut za Nuklearne Nauke Boris Kidric, Belgrade (Yugoslavia)). pp 183-189 of Mechanical engineering energetic. Proceedings of symposium papers. Beograd; Masinski Fakultet Univerziteta u Beogradu (1977). (In Serbian)

From Symposium of mechanical engineering energetic; Beograd, Yugoslavia (1 Dec 1977).

This paper deals with nuclear power plant mixed cooling system and problem of environmental impact predictions. Comparation is made with environmental impact of cooling towers working in recirculation cooling system.

383 HYPERTHERMAL EFFLUENT EFFECTS ON HELEOPLANKTONIC CLADOCERA AND THE INFLUENCE OF SUBMERGED MACROPHYTES. Vigerstad, T.J. (Univ. of Rhode Island, Kingston); Tilly, L.J. Hydrobiologie ; 55: No. 1, 81-85(1977).

In July and August 1974, measurements were made of the standing crops of Cladocera in the littoral zone of Par Pond (Savannah River Plant, Aiken, South Carolina, USA), which receives hyperthermal effluent from a nuclear reactor. Crops of Ceriodaphnia spp. and Diaphanosoma brachyurum were greater in the heated than in the ambient area, while Bosmina longirostris maintained higher standing crops in the ambient area than in the area receiving hyperthermal effluent. In August 1974, exclosures were placed in the effluent-affected area to test the hypothesis that the high density of rooted aquatic macrophytes in the effluent-affected area influences the standing crop of these Cladocera. The effects of changes in reactor effluent temperature were also determined in the exclosure experiments. The results of the exclosure study support two generalizations: (1) the presence of dense rooted vegetation allows higher standing crops of Ceriodaphnia spp. and D. brachyurum; and (2) lower temperatures than those usually found at the heated station would favor B. longirostris standing crops, while the higher effluent temperatures favor Ceriodaphnia spp. and D. brachyurum.

384 STATISTICAL COMPARISON AND CHOICES OF SAMPLING DESIGNS FOR ESTIMATING FISH IMPINGEMENT AT COOLING WATER INTAKES. Murarka, I.P.; Spigarelli, S.A.; Bodeau, D.J. Argonne, IL; Argonne National Laboratory (1977). vp.

In the preceding discussions we have compared six sampling schemes from the viewpoint of statistical efficiency and appropriateness for estimating fish impingement at cooling water intakes. On the basis of the theory and applications to simulated and actual data sets, at least three sampling schemes are suitable for use in fish impingement studies. The design considerations depend to a great extent on the end use postulated. Therefore, it is necessary to address the purposes of impingement sampling from a biological standpoint before determining the nature of sampling designs.

385 STRESS CORROSION CRACKING OF ADMIRALTY BRASS IN AQUEOUS COPPER SULFATE. Pinchback, T.R.; Clough, S.P.; Heldt, L.A. (Michigan Technological Univ., Houghton). Corrosion; 32: No. 12, 469-471(Dec 1976).

Admiralty brass (Cu--Zn--Sn) is shown to be susceptible to stress corrosion cracking (SCC) in copper sulfate solutions. Fracture surfaces of the resultant transgranular cracks are characterized by cleavage like features. Surface analysis by scanning Auger microprobe revealed a high concentration of tin at the leading edge of the propagating stress corrosion crack. The fractographic features and the presence of tin suggest that hydrogen embrittlement may be involved in the cracking mechanism.

386 EQUIPMENT FOR COOLING DOWN LARGE VOLUMINA OF HEATED WATER, E.G. INDUSTRIAL SEWAGE. Frohwerk, P.A. (to Ceramic Cooling Tower Co., Fort Worth, Tex. (USA)). German(FRG) Patent 2,104,631/C/. 18 Nov 1976. 8p. (In German).

The invention deals with a sort of substitute for a cooling tower which seams to be particularly suitable where heated industrial sewage water - provided that all other purity conditions are met - is to be cooled down to an admissible temperature before being conducted into waters, in order to avoid so-called 'thermal pollution'. According to the invention, the construction on the unit construction system, whose final assembly can easily be executed in-situ, is regarded as being an advantage allowing a subsequent, quick adaptation to the performance actually required, which cannot always be calculated precisely. A 'combined pump and spray device' represents the building block. Such a device contains, e.g., 4 spray units and 1 pump unit consisting in each case of one floating body and one spray resp. pump head on top of it. Being the smallest unit, this device is to float generally in a relatirely narrow working duct, therefore these five units are arranged in series alongside the current flow. The four spray units have a distance of 12 m from each other and cover this distance with their fan-shaped spray jets directed upwards. The pump unit is arranged in the centre of the inner spray unit. The pipes arranged under the five units connect them rigidly. The water taken in and pressurized by the pump is conducted into the spray units by these pipes. The system is anchored on the canal floor and on the bank in

a suitable manner. As an arrangement cross to the current flow may be suitable for broader canals, several possible combinations of such devices are explained. A cooling capacity of 3.8 million liters per minute or more with a temperature reduction by 11 to 14°C is given while approaching the ambient wet temperature of about 5 to 6°C.

387 EFFLUENT GUIDELINES AND STANDARDS: STEAM ELECTRIC POWER GENERATING POINT SOURCE CATEGORY. ENVIRONMENTAL PROTECTION AGENCY, WASHINGTON, DC. Fed. Regist. (Wash., D.C.); 41: No. 60, 12694-12697(26 Mar 1976).

The Environmental Protection Agency (EPA) has promulgated the Steam Electric Power Generating Point Source Category regulations. The regulations provide that new sources may not discharge heat to navigable waters unless such discharge is from cooling towers or off-stream cooling ponds. The EPA now believes that cooling lakes may, in some cases, be preferable to other methods of providing control of thermal discharges. Man-made lakes for thermal cooling will be permitted where such lakes are deemed the best available demonstrated technology. The regulations impose a three criteria test to be applied by the regional administrator in order to make this determination. First, a study must be made to assure that both the construction and operation of the impoundment or body of water will not adversely affect municipal water supplies, shellfish beds, fishery areas, wildlife, or recreational areas. Secondly, a determination must be made that the discharge from the water body contains no more than 2% of the waste condensor heat passed to the cooling water body. Finally, a recirculation requirement will be imposed establishing a flow restriction limiting the total discharges from the water body, on a long-term average annual basis, to no more than 100 cubic feet per second per thousand megawatt generating capacity of the facility.

388 HEAT EXCHANGER. Molina, C.; Brisseaux, A. French Patent 2,338,473/A/. 19 Jan 1976. 6p. (In French).

This invention concerns a heat exchanger between a fluid flowing through a tube and a gas. Such an exchanger can be used, inter alia, for removing calories that cannot be used for generating electricity in a thermal or nuclear power station. This exchanger can withstand any pressure surges in the system and even the use of a high vapour pressure coolant such as ammonia, since the fluid flows in a round tube with low pressure drops (both with respect to the fluid to be cooled and the cooling air). It is rigid enough to stand up to being moved and handled as well as to gusts of wind. It is formed of units that can be handled without difficulty and that are easily dismantable and interchangeable, even in service, and it is easily maintained. The exchange area is high for a minimum frontal area and this enables the size of the supporting frame to be reduced and makes it easy to hide it behind a screen of trees should this prove necessary. Finally, it is composed of a small number of standard units thus reducing the industrial production cost. These units are rectangular plates, each one being a flat tubular coil fitted between two flat parallel sheet metal plates having on their outer sides flat top raised bosses. These units are assembled together by the tops of the bosses so as to form an exchanger bank, each bank comprising two collectors to which the bank coils are tightly connected.

389 NUMERICAL SIMULATION OF COOLING TOWER DRIFT ELIMINATOR PERFORMANCE. Chan, J.; Golay, M.W. (Massachusetts Inst. of Tech., Cambridge). pp 229-241 of Numerical/laboratory computer methods in fluid mechanics. Pouring, A.A.; Shah, V.L. (eds.). New York, NY; American Society of Mechanical Engineers (1976).

From Winter meeting of the ASME; New York, NY, USA (5 Dec 1976).

An analysis of the performance of standard industrial cooling tower drift eliminators using numerical simulation experiments have been performed. These simulations make use of the code SOLA (1) which calculates two-dimensional laminar flow in a drift eliminator geometry. This information is then used to obtain the eliminator collection efficiency by performing trajectory calculations for droplets of a given size by a fourth order Runge-Kutta numerical method. These calculations are performed for various types of eliminators including some commonly used industrial eliminators.

390 ENVIRONMENTAL EVALUATION OF A NUCLEAR POWER PLANT ON LAKE ERIE: SOME AQUATIC IMPACTS. Reutter, J.M. Columbus, OH; Ohio State Univ. (1976). 49p. University Microfilms Order No. 77-2758.

Thesis (Ph. D.).

The Toledo Edison Company and The Cleveland Electric Illuminating Company are currently building the first unit of the Davis-Besse Nuclear Power Station on the south shore of Lake Erie at Locust Point. This plant will utilize water from Lake Erie for cooling purposes and to replenish the cooling tower blowdown which will be returned to the lake at the maximum of 11.1°C above ambient. Laboratory experiments were conducted on Lake Erie fish to determine their seasonal final temperature preferenda and the effects of sudden temperature changes. These results were correlated with the existing fish community at Locust Point to predict the effects of the thermal discharge from the Davis-Besse Nuclear Power Station on the surrounding fish community and to predict the effects of thermal discharges, in general, on the Lake Erie fishery resource. Phytoplankton populations, zooplankton populations and several water quality parameters were measured at Locust Point in 1974 and 1975. Correlation coefficients and multiple regressions were computed using these plankton populations and the water quality parameters to determine the extent to which the existing plankton populations are effected by the water quality. Over 2000 fish representing 24 species were tested to determine their final temperature preferenda.

391 SEASONAL DISTRIBUTION AND SUCCESSIONAL TRENDS OF FISH IN A NEW COOLING RESERVOIR. Triplett, J.R. Kansas City, KS; Univ. of Kansas (1976). 153p. University Microfilms Order No. 77-2290.

Thesis (Ph. D.).

The fish populations in La Cygne Lake, a 1052 hectare reservoir in eastern Kansas, were studied from November 1971 through October 1974. The reservoir, impounded in 1970, was constructed as a cooling pond for an 840 megawatt power plant. Three locations in the lake were sampled monthly by overnight sets of modified fyke traps in order to characterize changes in the fish populations as the reservoir aged and the power plant began operation. Characteristic of new impoundments, large populations of fish developed during the first two years (1970 and 1971) of impoundment.

Severe competition for resources resulted in poor growth of those populations and cropping of the young-of-year in 1972 and 1973. Attrition of the dominant 1970 and 1971 year-classes reduced competition and resulted in increased growth and production during 1974. The 1971 year-class of white crappie (Pomoxis annularis), dominated the fish populations and maintained a competitive advantage by opportunistically partitioning the resources among its adult members. The initiation of power plant operation in 1973 resulted in a nearly continuous congregation of fish in the outfall area. Large piscivores dominated the area in the winter and smaller fish were prevalent in the summer.

392 SOLAR BUILDING ENERGY USE ANALYSIS. Ucar, M. Syracuse, NY; Syracuse Univ. (1976). 221p. University Microfilms Order No. 77-24,410.

Thesis (Ph. D.).

A generalized algorithmic computer program has been developed for the mathematical simulation of the thermal behavior of solar buildings. The system modelled employs a series of water-to-air heat pumps connected in a closed loop; flat plate water cooled solar collectors; a water storage tank; and a cooling tower. This combination is very well suited to institutional buildings. The solar collectors have seasonal efficiencies of the order of 60% at the low source temperatures needed for heat pumps. Unitary heat pumps have the advantage of heating the perimeter of the building by pumping the heat generated in the interior. The computer program, SYRSOL, performs a complete analysis of the building and the HVAC system without the use of any auxiliary programs. It provides a realistic and economical method of calculating the heat loads, and the energy consumption of the building. The system components are modelled after commercially available equipment. A multi-zone hour-by-hour calculation approach is taken. Every hour a complete heat and mass balance is performed on each zone. Weather data are represented by sinusoids. This saves considerable amounts of programming and computing time. It is concluded that the mathematical model describes the physical system realistically and that the computer program performs a sufficiently detailed and accurate simulation for engineering purposes using relatively little computer time and computer memory.

393 SEISMIC ANALYSIS OF HYPERBOLIC COOLING TOWERS BY THE RESPONSE SPECTRUM METHOD. Gould, P.L.; Sen, S.K.; Suryoutomo, H. (Washinton Univ., St. Louis, MO). pp 987-1005 of International symposium on earthquake structural engineering. Vol. II. Cheng, F.Y. (ed.). Rolla, MO; Univ. of Missouri (1976).

From International symposium on earthquake structural engineering; St Louis, MO, USA (19 Aug 1976).

A free vibration finite element analysis for rotational shells is developed and applied to the seismic analysis of hyperbolic cooling towers. In the numerical studies, particular attention is drawn to the influence of the system of supporting columns on the dynamic stresses and deformations.

394 COOLING TOWER PLUME MEASUREMENTS. Winiarski, L.; Frick, W.; Tichenor, B. (Environmental Protection Agency, Corvallis, OR). pp 33.5.1-33.5.4 of 1975 environmental sensing and assessment. New York, NY; Institute of Electrical and Electronics Engineers, Inc. (1976).

From IEEE international conference on environmental sensing and assessment; Las Vegas, NV, USA (15 Sep 1975).

A novel plume sampling technique was devised in order to measure the distribution of temperature and humidity in the invisible portion of a cooling tower plume. These measurements, together with simultaneous measurements of the local meteorology and the exit plume conditions, are particularly useful in moist plume modeling work. The data were reduced to a series of plots to show the temperature and mixing ratio (grams of water per kilogram of air) as a function of the height above the ground. Data on the tower effluent including velocity, temperature, and particle size distribution were also collected. These coupled with the onsite wind speed as well as the temperature and humidity data taken above and below the plume, gave a complete data set of the pertinent factors governing moist plume behavior.

395 THERMAL EFFLUENT AND THE EPIZOOTIOLOGY OF THE CILIATE EPISTYLIS AND THE BACTERIUM AEROMONAS IN ASSOCIATION WITH CENTRARCHID FISH. Esch, G.W.; Hazen, T.C.; Dimock, R.V. Jr; Gibbons, J.W. (Wake Forest Univ., Winston-Salem, NC). Trans. Am. Microsc. Soc.; 95: No. 4, 687-693(1976).

Epistylis sp. (Caliophora: Peritricha) is a facultative ectosymbiont of fresh-water fishes in streams and lakes throughout the southeastern U.S. In combination with the gram-negative bacteria Aeromonas hydrophila, epizootic outbreaks of Epistylis have been implicated in the death of many thousands of game fish, primarily striped bass and several species of Centrarchidae (sunfish), in several reservoirs in North Carolina. While these epizootics have been correlated with high levels of organic loading, recent studies suggest that thermal loading from a nuclear production facility may influence the level of infection by A. hydrophila and Epistylis sp. (A-E complex) on centrarchid sunfish in Par Pond, Savannah River Plant, Aiken, S.C. Utilizing electro-fishing techniques, in excess of 11,500 sunfish, representing six different species, were collected and examined for external lesions associated with the A-E complex. Largemouth bass (Micropterus salmoides) were most heavily infected, followed in incidence of infection by bluegill (Lepomis macrochirus), warmouth (Lepomis gulosus) and redbreast sunfish (Lepomis auritus); lesions were not observed on the surface of black crappie (Pomoxis nigromaculatus). The body conditions (or K-factor) of more than 2,000 largemouth bass were calculated; direct correlations were found between thermal loading, body condition, and incidence of infection. These data are discussed in terms of thermal effluent and the epizootiology of Epistylis sp. and Aeromonas hydrophila.

396 ENVIRONMENTAL IMPACTS OF BLOWDOWN FROM SALTWATER COOLING TOWERS AS COMPARED TO FRESHWATER COOLING TOWERS. Roffman, H.; Roffman, A. (Westinghouse Environmental Systems Dept., Pittsburgh, PA). pp 253-276 of Materials: dispose or recycle. Rolsten, R.F. (ed.). Dayton, OH; The Wright Company (1976).

From 2. international conference on environmental problems of the extractive industries; Dayton, OH, USA (15 Jun 1975).

To maintain a high number of cycles of concentrations in the cooling tower, scaling must be kept at a minimum. The most common scale-forming minerals contain calcium, magnesium, and silica. In fresh-water cooling

systems, it is common practice to add sufficient sulfuric acid and to lower the pH to the point where the water has a negative Langelier Index and the scale-forming salts are kept in solution. The solubility of such salts is usually also increased in the presence of other ions in the same solution. Thus, the higher ionic strength of brackish or sea waters may reduce the required acidification. Elimination or reduction of acidification reduces corrosion rates of metals that are higher when salt water is used rather than fresh water. Corrosion problems associated with salt waters usually require the utilization of noncorrosive metals as extensively as is economically possible. Cooling tower waters must also be treated for biological fouling. In fresh water cooling towers, biological fouling is usually prevented by continuous or intermittent chlorination, both being environmentally undesirable. Salinity in high concentrations has been proven to be quite toxic to marine organisms, and chlorination of circulating salt waters may not always be required.

397 COOLING PROCESS AND DEVICE FOR LIQUID OR VAPORIZED FLUIDS. (to Usines Chausson, 92 - Asnieres (France)). French Patent 2,319,098/A/. 21 Jul 1975. 10p. (In French).

The process described in the invention concerns the condensation of steam from the low pressure stages of the turbines driving the electricity generators in thermal or nuclear power stations. It enables much smaller cooling units to be built than the cooling towers used so far. In this process the atmospheric air is charged with only a small amount of extra steam. Also, when the air temperature is low, the outside air is no longer overloaded with steam, thereby making it possible to avoid creating harmful micro-climates and also saving appreciable amounts of water. An exchanger forms one circuit for the fluid to be cooled, separated by a partition from a second circuit swept by atmospheric air. Each one of the two circuits is composed of tubes with a hydraulic diameter not exceeding 4 mm. In the second circuit on the air swept side a quantity of water is brought in amounting to between 0 and 50g/kg of dry air crossing it.

398 PROCESS AND DEVICE FOR COOLING LIQUID OR VAPORISED FLUIDS. (to Usines Chausson, 92 - Asnieres (France)). French Patent 2,319,098/A/. 21 Jul 1975. 10p. (In French).

The invention relates to a process for the ambient air cooling of liquid fluids or those vaporised under low pressure. An exchanger composing a first circuit for the fluid to be cooled is set up and is separated by a partition from a second circuit swept by the atmospheric air. Each one of these two circuits is made up of pipes of not more than 4 mm hydraulic diameter and on the side of the second circuit swept by the air a quantity of water is brought to the extent of 0 to 50 g/kg of dry air crossing it. The water is sprayed into the second circuit. The tubes of the second circuit are set up so that the water sprayed on, runs down the partition separating the two circuits. The water is sprayed counter-current with respect to the direction of the cooling air. A quantity of water is projected into the second circuit depending on the thermal flow to be exchanged and the desired cooling temperature, the amount of water being limited so that the outgoing air, returned to the atmosphere, contains an amount of water per kilogram of dry air corresponding to the absolute moisture of the saturated air for the dry ambient temperature at the time. The process affords all the advantages of a wet cooling tower, great efficiency and low temperature.

399 HEAT DISTRIBUTION COMPENSATING CIRCUIT INTENDED FOR COOLING THERMAL AND NUCLEAR POWER PLANTS. Couillaud, P. French Patent 2,308,060/A/. 18 Apr 1975. 8p. (In French).

In long distance heat transmission and distribution systems, as designed so far, when the temperature of the air rises, the amount of heat distributed diminishes and the amount of heat lost through the walls of the pipe diminishing too, these systems absorb much less heat in summer than in winter and this is a serious drawback when they contribute in cooling a nuclear power station or other thermal power station. In the compensating system described in this invention, although the amount of heat distributed diminishes with the rise in air temperature, the amount of heat lost through the walls of the return line rises. This can enable such a system to be made to absorb as much heat in the summer as in winter, and should the need arise in certain cases, more heat in summer than in winter, when these lines are long enough. Contrary to normal heat transmission and distribution line systems where the pipes are insulated throughout their entire length, in the type of system described in this invention, only the 'outward' pipe is insulated the larger section 'return' pipe is not insulated and works as a heat diffuser, either into the air when there is no frost risk or into the ground to a shallow depth.

400 (ANL-Trans--1155) WATER VAPOR IMMISSIONS IN THE REGION OF A CONVENTIONAL THERMAL POWER STATION. Berge, H.; King, E.; Lorenz, D. Translated from Fortsch.-Ber. VDI Z. Reihe; 15: No. 6, 128(1975). 86p. Dep. NTIS, PC A05/MF A01.

The effects on cultivated plants of operating thermal power plants with cooling towers were studied. The two principal areas of interest were the effects of cooling tower plumes on local meteorological conditions and hydrogen fluorine emissions from cooling towers. The effects of cooling tower plumes on the following variables were measured: solar radiation received at soil surface; air temperature; humidity; precipitation; leaf-wetting duration; moisture in ears of grain; plume configuration; fluorine emissions and fluorine content in air, soil, and crops. Results from investigating the area within a 650 m radius of the cooling tower complex led to the following conclusions. Direct influences of cooling tower emissions on the ground, and hence on the vegetation, principally come from the effect of the shadow of the cooling tower plume. Light losses within a 500 m circle can amount to 5 to 25%. Beyond 1000 m the effect is imperceptible. The cooling tower plume, in its immediate neighborhood, can in addition, occasionally lead to an intensification of the precipitation. Reliable quantitative data cannot be published on the basis of the precipitation measurements available. The waste heat of the power station and probably of the boiler house, in particular, leads to an increase of the air temperature on the leeward side and to a decrease in the relative humidity; these values are dependent upon the exchange conditions. (LCL)

401 OPERATIONAL RESULTS OF ONUMA GEOTHERMAL POWER PLANT. Furuto, K. (Geothermal Energy Development Dept., Mitsubishi Metal Corporation, Japan), Miyazaki, A. J. Jpn.

Geotherm. Energy Assoc.; 12: No. 1, 21-23(1975). (In Japanese).

The development and operation of the Onuma geothermal power plant is reviewed. Since 1965, six investigative wells, three production wells, and three reinjection wells have been drilled. A 10,000 kW power plant was completed in 1973 in the Hachimantai area. Test operation was begun at 6000 kW in November 1973 and during the next 11 months, 36,977 MWh were generated. Facilities include a single cylinder pulse-type condensation turbine with a rated power output of 10,000 kW, a barometric condenser, two horizontal-motor reciprocating vacuum pump, a forced-ventillation, double-suction cooling tower, a cylindrical rotating field-synchronous generator and a three-phase 12,000 kVA/12,000kVA/1500kVA transformer. Operational difficulties have been encountered with the condenser and cooling water. At one point, sediments deposited on the condenser and water spray plate reduced power output from 6000 to 5200 kW. The pH of the cooling water had to be regulated to a pH of 6.8 to 7.0 by addition of NaOH. There was also a problem with snow accumulation and water and air pollution. A 50,000 kW plant is being planned. Three tables are provided.

402 CONSTRUCTION OF THE ONIKOBE GEOTHERMAL POWER PLANT. Karube, J. (Onikobe Power Plant, Electric Power Development Co., Japan). J. Jpn. Geotherm. Energy Assoc.; 12: No. 1, 24-26(1975). (In Japanese).

The Onikobe geothermal power plant is located in the Kurikoma National Park about 20 km from the Naruo hot springs in Tamatsukuri-gun, Miyagi Prefecture. Following geothermal exploration in 1972, construction began in 1973, and commercial operation is planned for April 1975. Trial operation of the plant is beginning. The installation includes single-cylinder condensing turbines, horizontal shaft, revolving-field, enclosed, self-ventilating generators, and cooling towers with a capacity of 7,670 t/h. Twelve production wells 300 m deep produce good quality steam which should generate 25,000 kW power.

403 ENVIRONMENTAL AND ECONOMIC IMPACTS OF OPEN-CYCLE AND CLOSED-CYCLE CONDENSER COOLING SYSTEMS FOR LARGE ELECTRIC GENERATING STATIONS. Hedden, D.T. (Northeast Utilities, Hartford, CT). pp 159-162 of WateReuse: water's interface with energy, air, and solids. New York, NY; American Institute of Chemical Engineers (1975).

From 2. national conference on complete water use; Chicago, IL, USA (4 May 1975).

THERMAL POWER PLANTS;OPEN-CYCLE COOLING SYSTEMS;CLOSED-CYCLE COOLING SYSTEMS; COMPARATIVE EVALUATIONS;ENVIRONMENTAL IMPACTS; ECONOMIC IMPACT

404 DESIGN CONSIDERATIONS FOR A MECHANICAL DRAFT COOLING TOWER. Foy, H. (Consolidated Edison of New York, NY). pp 495-500 of WateReuse: water's interface with energy, air, and solids. New York, NY; American Institute of Chemical Engineers (1975).

From 2. national conference on complete water use; Chicago, IL, USA (4 May 1975).

A methodology is presented for selecting optimum design parameters for wet mechanical draft cooling towers augmented with heat exchangers for dry cooling. Details of this approach are illustrated by evaluating a hypothetical 1,000 MW steam-electric plant in the northeastern US where water resources are abundant but cooling-tower-induced fog is undesirable. It is concluded that to design a cooling tower based on fog abatement, natural fog frequency must be identified in order to establish criteria on cooling-tower-induced fog. An optimum designed cooling tower is one whose dry section is capable of dissipating a minimum amount of heat and yet can control its induced fog within a predetermined criterion. Mathematical models, together with meteorological data, are used to predict the distribution of cooling-tower-induced fog. (LCL)

405 SEISMIC DESIGN OF HYPERBOLIC COOLING TOWERS. Gould, P.L. (Washington Univ., St. Louis, MO). pp 1075-1084 of Structural design of nuclear plant facilities. Volume I-B. New York, NY; American Society of Civil Engineers (1975).

From ASCE specialty conference; New Orleans, LA, USA (8 Dec 1975).

Hyperbolic cooling towers have been constructed to heights approaching 500 ft. and are basically thin shells of revolution supported atop a system of closely spaced columns which border the air intake space. The ring of columns forms a rather abrupt discontinuity between the shell and the foundation and plays an important role in the response of the structure to seismic excitation. The effect of wind forces on hyperbolic cooling towers is rather severe as compared with a rectangular building structure of similar proportions. This occurs because of the geometric form and the surface characteristics. As a result, cooling towers designed for extreme wind conditions can often meet earthquake design criteria as well. However, in some situations the seismic conditions may control and the problem merits careful attention.

406 LIQUEFACTION CONSIDERATIONS FOR TWO SUMMERGED ESSENTIAL SERVICE COOLING PONDS. Holish, L.L. (Sargent and Lundy Engineers, Chicago, IL); Hendron, D.H. pp 887-931 of Structural design of nuclear plant facilities. Volume I-B. New York, NY; American Society of Civil Engineers (1975).

From ASCE specialty conference; New Orleans, LA, USA (8 Dec 1975).

Prediction of the response of soils to earthquake motion is limited by the present state of the art techniques for the behavior of soils when dynamically loaded. The limitations occur normally in two areas first, knowledge of techniques for testing soils to establish reliable dynamic characteristics economically; and second, the ability to emperically predict the results after liquefaction, that is extent and duration of movement. Two cases are presented where known techniques have been incorporated to extend the knowledge of testing and behavior of a liquefied mass.

407 ENERGY OPTIMIZATION OF COOLING TOWER BLOWDOWN RECOVERY. Ahlgren, R.M. (Aqua-Chem, Inc., Milwaukee, WI). pp 515-519 of WateReuse: water's interface with energy, air, and solids. New York, NY; American Institute of Chemical Engineers (1975).

From 2. national conference on complete water use; Chicago, IL, USA (4 May 1975).

ENERGY CONSERVATION;OPTIMIZATION;COOLING TOWERS;BLOWDOWN;RECOVERY;COOLANTS;EVAPORATION

408 COOLING TOWER OPERATIONS WITH AIR/WATER INTERFACE AND ENERGY CONSIDERATIONS. Burger, R. (Robert Burger Associates, Inc., New York, NY). pp 520-527 of WateReuse: water's interface with energy, air, and solids. New

York, NY; American Institute of Chemical Engineers (1975).
From 2. national conference on complete water use; Chicago, IL, USA (4 May 1975).
Air and water interface is the basic premise of cooling tower operation. The heat rejection fundamentals of a cooling tower are based upon two mechnisms: loss of sensible heat by the colder air picking up the heat of the water; and evaporative condensation generated by the air and water latent heat of vaporization process. The paper discusses the upgrading for greater efficiency, using less horsepower and investment dollars, plus maintenance of the most prevalent types of modern cooling towers in use today.

409 RECYCLE OF POWER PLANT COOLING TOWER BLOWDOWN BY VERTICAL TUBE EVAPORATION WITH INTERFACE ENHANCEMENT UTILIZING WASTE HEAT. Sephton, H.H. (Univ. of California, Richmond). pp 564-571 of WateReuse: water's interface with energy, air, and solids. New York, NY; American Institute of Chemical Engineers (1975).
From 2. national conference on complete water use; Chicago, IL, USA (4 May 1975).
COOLING TOWERS;POWER PLANTS;BLOWDOWN; RECYCLING;WATER;AIR;INTERFACES;WASTE HEAT; RECOVERY

410 REUSE OF WASTEWATER EFFLUENT AS COOLING TOWER MAKEUP WATER. Fleischman, M. (Univ. of Louisville, KY). pp 501-514 of WateReuse: water's interface with energy, air, and solids. New York, NY; American Institute of Chemical Engineers (1975).
From 2. national conference on complete water use; Chicago, IL, USA (4 May 1975).
A state of the art survey was made to identify problems due to various wastewater components and associated concentrations, further possible external treatment of wastewater effluent and cooling tower internal treatment, considerations in materials of construction, blowdown disposal considerations, and tradeoffs and interactions between further treatment, additives, cleaning procedures, etc. The highlights of this study are summarized. Data indicate that unless the effluent is blended with clarified river water, further effluent treatment for reduction of TOD, NH_3m and suspended solids would be necessary for reuse as cooling tower makeup. Reuse of chemical plant advanced waste treatment effluent as cooling tower makeup looks feasible and two approaches are possible for implementation: preparation of a design basis by means of complete wastestream characterization and material balances, and laboratory and pilot testing to get necessary performance evaluation and design data. Pilot tests are recommended. (JGB)

411 FINITE ELEMENT LAKE CIRCULATION AND THERMAL ANALYSIS. Gallagher, R.H. (Cornell Univ., Ithaca, NY). pp 119-131 of Finite elements in fluids. Volume I. Viscous flow and hydrodynamics. Gallagher, R.H.; Oden, J.T.; Taylor, C.; Zienkiewicz, O.C. (eds.). New York, NY; Wiley and Sons (1975).
From International symposium on finite elements methods in flow problems; Swansea, UK (7 Jan 1974).
The finite element procedures available for calculation of the temperature distributions due to dissipation of heat from operation of a nuclear power plant are reviewed. The use of fresh water lakes, cooling towers, and cooling wells are considered. The fundamental physical problem with which this review is concerned is the flow, as defined by the distribution of velocities. The steady state portion of this flow is caused by the action of the wind on the surface of the lake. Basic methods of finite element analysis of the wind-driven circulation of lakes are therefore first reviewed; a number of alternative finite element representations are also identified. Various features of practical importance are neglected in the basic representations of wind-driven lake circulation. These include the presence of islands, the existence of thermal stratification and the three-dimensional character of the real lake. A section is devoted to examination of finite element developments which seek to account for these factors. For special circumstances it is possible to employ the simplest finite element representations of heat transport in a body of water. The velocities are calculated by means of the flow analysis procedures cited above and are used in the discretized form of the heat transport equations. A brief outline is given of published results in this type of analysis. The chapter concludes with comments regarding the sources of information about the physical conditions at the outfalls of heated effluents.

412 EFFECT OF TEMPERATURE ON THE SEASONAL POPULATION DYNAMICS AND FECUNDITY OF LEPTODORA KINDTI (FOCKE) (CLADOCERA) IN THE VICINITY OF POINT OF DISCHARGE OF WARM EFFLUENT OF THE KONOKOVA POWER PLANT. Kuzichkin, A.P. (Inst. of Biology of Inland Waters, Borok, USSR). Hydrobiol. J. (USSR) (Engl. Transl.); No. 2, 53-56(1975).
There is an extensive literature on the effect of heat on aquatic organisms, especially the common cladoceran species. Hot effluent in cooling ponds produces stretches in which a high temperature persists throughout the year. A high water temperature prolongs the growing season and causes quite perceptible changes in the zooplankton. For example, in the spring cladocerans start intensive reproduction a month earlier in the cooling pond of the Kurakhovka Power Plant and in fall they disappear from the plankton much later. In the Ivan'kovo Reservoir, in the zone of effluent from the Konokova Power Plant, the zooplankton in spring and fall is 5 to 10 times more abundant than in the unheated reservoir, whereas in summer, in the warmest time of the year, the situation is reversed and the population diminishes sharply in the heated zone. A summer population decrease is characteristic of many cladocerans in the temperate latitudes not only in the heated zone but also in waters where the temperatures are natural. According to some investigators, this is due to a halt of crustacean reproduction, manifested chiefly by a reduction in the number of eggs in a clutch.

413 COOLING TOWER AND MAKEUP WATER TREATMENT ELIMINATE CONDENSER DEPOSITS. Thompson, R.B. (Duke Power Co., Charlotte, NC). pp 25-28 of Proceedings of the 35th international water conference. Pittsburgh; Engineers' Society of Western Pennsylvania (1974).
From 35. international water conference; Pittsburgh, PA, USA (29 Oct 1974).
Steps taken by the Duke Power Co. to control condenser tube deposits and thereby improve cooling tower operation at its 770 MW coal-fired Cliffside Steam Station are described. These steps included control over the alum feed for water clarification, adding aminomethylene phosphonate to the cooling water to prevent precipitation of aluminum silicate, and silt control. After trial runs a cationic polyelectrolyte and clay coagulant aid were

used in the clarifier. The results achieved were: improved and lower cost water clarification; makeup demineralizer runs have doubled which reduced regenerant and rinse water requirements by almost 50%; and cooling tower concentrations can now be maintained with reduced bleed-off, makeup water, and treatment chemicals. (LCL)

414 (ANL-Trans--1145) CONVECTION ABOVE COOLING TOWERS. Rudolf, B.; Fraedrich, K. Translated from Ann. Meteorol.; No. 9, 65-68(1974). 14p. Dep. NTIS, PC A02/MF A01.
Cooling towers are local sources of heat and moisture. The convection above such a source is here computed by a simple one-dimensional model based upon the equation of motion in the vertical, the first law of thermodynamics, and the continuity equation. The following assumptions are introduced: quasi-hydrostatic equilibrium, steady state conditions, and a top-hat profile. Temperature, vertical velocity, and water content of the ascending air above the cooling tower are calculated for given environmental conditions (wind, temperature, moisture). The net fluxes of sensible and latent heat and the rate of condensation are derived. The processes inside the cooling tower are computed by a separate model to obtain the boundary conditions at the base of the plume (i.e. the top of the cooling tower). The behavior of the ascending air is classified as follows: (1) No cloud generation, (2) vertically limited cloud generation, and (3) a cloud which rises to an unlimited height. Through computation it is determined which of the above classes can be expected under different environmental conditions. The results are represented by stability-moisture diagrams for a dry and a wet cooling tower of the same heat generating magnitudes.

415 STEAM PLANT OPERATION. London, Eng.; Institution of Mechanical Engineers (1974). 282p. (In German and English). (CONF-7305135--). $32.30.
From Conference on steam plant operation; London, UK (2 May 1973).
Thirty papers on the design, operation, and performance of fossil-fueled and nuclear steam power plants and marine propulsion steam engines are presented. Information is included on power plant emissions, components such as cooling systems, control systems, boilers, turbines, and on combined-cycle power plants. Subject and author indexes are provided. (LCL)

416 COOLING TOWER DRIFT MODEL. Tsai, Y.J.; Johnson, D.H. (Stone and Webster Engineering Corp., Boston, MA). pp 143 of Modeling and simulation. Volume 5. Part 1. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh, PA; Instrument Society of America (1974).
From 5. conference on modeling and simulation; Pittsburgh, PA, USA (24 Apr 1974).
A computer model was developed to predict the distribution of drift from brackish or saltwater cooling towers for power plant condensate cooling. Drift from mechanical or natural draft towers can be evaluated, taking into account tower characteristics, drift rate, droplet size distribution, total dissolved solids in cooling water, rise of droplets in the plume, evaporation and trajectory of falling droplets, and ambient weather data.

417 HEAT TRANSFER SURVEY 1974. Butler, P. (ed.). London, England; Morgan-Grampian Ltd. (1974). 68p. pound2.
A separate abstract was prepared for 3 papers for the energy data base.

418 WINTER OPERATION OF MECHANICAL-DRAUGHT COOLING TOWERS. Cabral, B.F.A. (Carter Industrial Products Ltd.). pp 45, 47 of Heat transfer survey 1974. Butler, P. (ed.). London, England; Morgan-Grampian Ltd. (1974).
How low ambient temperatures affect the performance of mechanical-draft cooling towers and the precautions necessary to prevent icing are discussed.

419 SOME EXTRA-HIGH CAPACITY HEAT EXCHANGERS OF SPECIAL DESIGN. Forgo, L. (HOETERV, Design Bureau for Industrial Power and Heat Supply, Budapest, Hungary). pp 101-129 of Heat exchangers: design and theory sourcebook. Afgan, N.H.; Schluender, E.U. (eds.). Washington, DC; Scripta Book Company (1974).
Advances in the design of high-capacity heat exchangers such as are needed for cooling towers in thermal power plants and for multiple reheating of steam for steam turbines are discussed.

420 SCALING UP OF A DIRECT CONTACT HEAT EXCHANGER. Perrut, M.; Paules, B. (Centre de Cinetique et Physique Chimique, Nancy, France). pp 817-830 of Heat exchangers: design and theory sourcebook. Afgan, N.H.; Schluender, E.U. (eds.). Washington, DC; Scripta Book Company (1974).
Spray tower hydrodynamics are analyzed, with calculations of mean drop size, and heat or mass transfer coefficients. Optimal design is arrived at using 3 parameters.

421 (PB--282561-T/SL) TRANSACTIONS OF THE VEDENEEV ALL-UNION SCIENTIFIC AND RESEARCH INSTITUTE OF HYDRAULIC ENGINEERING. VOLUME 99, 1972. Translated from Izv. Vses. Nauchno-Issled. Inst. Gidrotekh.; 99: 3-293(1972). 562p. (TT--75-55086). NTIS PC A24/MF A01.
No abstract available.

422 ATTENDANCE AT THE INTERNATIONAL GEOTHERMAL SYMPOSIUM-OUTLINES OF SECTION VIII. Takahashi, Y. (Mitsubishi Heavy Industries, Ltd., Japan). J. Jpn. Geotherm. Energy Assoc.; No. 29, 68-74(1971). (In Japanese).
Discussion of papers presented at the UN Symposium on Development and Utilization of Geothermal Resources, Pisa, Italy, 1970..
Section VIII of an international geothermal symposium held in Pisa, Italy, in 1970, included 13 papers concerning the collection and transmission of geothermal fluids. Uchiyama concluded that the corrosion of concrete in a cooling tower in the Matsukawa geothermal field was less than that for Larderello geothermal field in Italy. Yanagase presented a study on the solution of the scaling problem in hot water feeding pipes in the Otake geothermal field. Rumi presented a report on a calculation of the relationship between wellhead diameter and the discharge of steam at Larderello. James et al. investigated the conditions for pressure drop and stability by experimental studies with 12 in. pipes having horizontal and vertical test sections. Results were similar to those obtained by Takahasi using 8 in. pipe, and results agreed with calculated values determined by the LochHart-Martinelli method for pressure drop. Also, the stability of flow is sufficient if the atomizing flow and annulus flow ranges are on the Baker flow pattern curve.

423 WELL NO. 3 AT HATCHOBARU GEOTHERMAL FIELD. J. Jpn. Geotherm. Energy Assoc.; No. 26, 3-5(1970). (In Japanese).

Drilling on the Hatchobara No. 3 well began on March 23, 1970, and at depths of 1065 m and 1089 m promising water was encountered. The final depth was 1089 m because further excavation was considered impossible. Swabbing attempted to determine exhalations. The steam and hot water contents of exhalations at a well head pressure of 5.0 kg/cm^{2}g were 38 t/h and 116 t/h, respectively. Exhalations are still increasing. Drill bits used were 3MS, 3MH, 3H, and R-I types, including hard openers. The drilling mud used was mainly bentonite but chrome was used in cases where the drilling mud was affected by high temperatures. The density of drilling mud during drilling was 1.04 to 1.20 and pH was 8.6 to 9.4. The temperature of the drilling mud rose rapidly from about 770 m below the surface to reach 98°C at a depth of 998 m. Thus, further drilling was cooled by a cooling tower, where the cooling effect was about 20°C. One map, two graphs and two tables are provided.

424 CLEANING OF GASES FROM THE INCINERATION OF WASTE MATERIALS. Whitehead, C.; Darby, K. pp 101-122 of Incineration of municipal and industrial waste. Vol. 1. Carter, G.T. (ed.). London; Institute of Fuel (1969).

From Conference on the incineration of municipal and industrial waste; Brighton, UK (25 Nov 1969).

The cleaning of waste gases from incinerator grates and the problems which can arise from the composition of the gas and the physical properties of the dust entrained in the gas are discussed. Reference is made to the various methods adopted for cooling the gas before final cleaning, and their effect on the size of the gas-cleaning plant. Special emphasis is laid on the evaporative cooling tower, and a brief resume is given of the results of an investigation into the flow characteristics of different tower designs. The application of four basid methods of gas cleaning to incinerators is discussed. Finally, a complete gas-cleaning plant is described based on an evaporative spray cooling tower, followed by an electrostatic precipitator, which indications show to be becoming the preferred method for incinerator gases in this country.

425 GEOTHERMAL PLANTS IN ITALY. Olivero, F.J. (University of Cordoba, Spain). Rev. Electrotec. ; 50: No. 2, 54-58(1964). (In Spanish).

A historical review of the uses of geothermal energy in Italy is presented with emphasis on the Larderello area. Authors in the Middle Ages referred to the natural vapor exhalations in the Tuscany region. At the beginning of the 19th century a Frenchman, Larderel, built an industry around the lagoons containing boric acid. A map of the Larderello area is presented, and borehole characteristics (depth, pressure, temperature, load) are given as well as costs and average life. The use of geothermal energy to generate electricity began in 1905. Various methods of vapor utilization are described. The power plants at Larderello are characterized by the large number of cooling towers, cooling is a problem because of limited cold water resources in the area. Geothermal electrical production in Italy is compared with production in Cordoba, Spain. The national railroad authority is the main owner of the Larderello plants and the principal user. The boric acid and borax industry also use the electricity. Three photographs and a detailed map of the industrial and residential center of Larderello are provided.

426 A 12.5 MW GEOTHERMAL PLANT IN CALIFORNIA. Electr. Times; 138: No. 6, 199-200(Aug 1960).

The first U. S. geothermal power station is described. A 12.5 MW turbogenerator with steam conditions of 100 lb/in.^{2} at 348°F went into operation at the Geysers in 1960. Enthalphy of three wells was determined to be about 1200 BTU/lb with steam flows, corresponding to a well pressure of 115 lb/in.^{2}, between 26 and 111 klb/h. Pressure fell quite sharply when flow rate was increased. For example, on the Magma No. 1 well, a pressure of 180 lb/in.^{2} at zero flow, fell to 100 lb/in.^{2} at a flow of 125 klb/h. Entrained gases in the steam ranged from CO_2 averaging 70% to NH_3 at 1.5%. Corrosion studies by Corrosometer are reviewed and the lay out of the power station consisting of power house, barometric condenser, pipe to hot well, incoming steam main, and three cooling towers, is detailed. The generator, rated at 12.5 MW 60 c/s, 13.5 kV is connected through a 250 MVA metalclad air circuit-breaker to the station step-up transformer, rated 12.5 MVA, 13.5/60 kV and also to an auxiliary station transformer.

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In the Corporate Index, report literature is indexed using the name of the organization or institution responsible for issuing the report. Headings are provided for all report literature and for published literature for which a corporate approach is especially desirable, e.g., symposium and conference proceedings.

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DOE Energy Information Data Base: Corporate Author Entries (TID-4585) is used in the standardization of corporate entries. TID-4585 is available for purchase from the National Technical Information Service (NTIS), U. S. Department of Commerce, Springfield, Virginia 22161.

77-734. Final report, 76 (EPRI-EA--922)

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UNITED ENGINEERS AND CONSTRUCTORS, INC., PHILADELPHIA, PA (USA)
Cooling systems addendum: capital and total generating cost studies, 107 (NUREG--0247)

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Authors' surnames are indexed in the form appearing in the abstracted publication; given names are reduced to initials. Each author entry gives the publication title and the citation number. Report numbers, if applicable, are given in parentheses at the end of the entry. For publications with multiple authors, an author entry is provided for each. Entries for the second and succeeding authors give references to the first author.

Because of problems involved in the mechanical preparation of this index, all accent marks are omitted. Changes in spelling introduced as a result of accent omission follow standard conventions.

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The subject index is based on the use of subject descriptors selected from a controlled thesaurus of terms. Subject descriptors and qualifiers (subheadings) are selected and presented in the following format:

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The title may be supplemented with additional words, or a phrase, if it appears additional information would be helpful. In cases for which the title contains little or no information related to the subject entry, it may be replaced entirely by the supplementary information. A qualifier is not always required, and in such cases the title will follow the unqualified subject descriptor.

The descriptors selected for use as subject terms are generally the names of specific materials, things, or processes. To the extent possible, a qualifier is selected to describe the properties of, or processes applied to, the subject term.

Index entries are selected to indicate the important ideas and concepts presented in the report, rather than words that may appear in the text. Within the available thesaurus terms, the most probable or logical place to look for typical information is selected. "See references" are included to guide users from synonymous terms or phrases to the descriptor selected as a subject heading for the concept. (e.g. Pipeline Quality Gas see HIGH BTU GAS). "See also references" are used to indicate where to find references to subject concepts that are narrower, broader, or related to a particular subject heading. to complete an exhaustive search of a given subject, all such headings should be reviewed.

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