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Draft Addendum to the final environmental statement

related to operation of

PALISADES NUCLEAR GENERATING PLANT

CONSUMERS POWER COMPANY

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Docket No. 50-255

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DRAFT ADDENDUM TO THE FINAL ENVIRONMENTAL STATEMENT RELATED TO OPERATION OF PALISADES NUCLEAR GENERATING PLANT

CONSUMERS POWER COMPANY

Docket No. 50-255

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OFFICE OF NUCLEAR REACTOR REGULATION

UNITED STATES NUCLEAR REGULATORY COMMISSION

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SUMMARY AND CONCLUSIONS

This addendum was prepared by the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation (the staff) in accordance with 10 CFR 51.23. The staff's basic evaluation is presented in the Final Environmental Statement Related to Operation of Palisades Nuclear Generating Plant (FES) issued in June 1972. New information and changes in staff evaluation or plant design are addressed in this addendum.

1. This action is administrative.

2. The proposed action is issuance of a full-term operating license at an increased power level to Consumers Power Company for operation of Palisades Nuclear Power Plant Unit No. 1 (the plant), Docket No. 50-255. The plant is presently operating under Provisional Operating License No. DPR-20 and amendments thereto.

   The plant, located on Lake Michigan in Van Buren County, Michigan, uses a pressurized water reactor to presently produce about 2200 megawatts thermal (MWt) to generate a net electrical output of 686 megawatts electrical (MWe). Under the proposed action, the plant will operate under 2638 MWT and 786 MWe. The steam condenser for the turbine will be cooled by water circulated through mechanical-draft cooling towers. Make-up water for the cooling towers will be taken from Lake Michigan, and the tower blowdown will be discharged into Lake Michigan.

3. Summary of environmental impacts and adverse environmental effects:

   a. The modified cooling system, utilizing mechanical-draft cooling towers, significantly reduces amount of lake water drawn into and discharged from the plant; thus, impingement, entrainment, and thermal effects on aquatic biota are reduced. No significant adverse effects are expected.

   b. The modified radwaste system reduces radiological releases from the plant.

   c. The power increase to 2638 MWt will not have a significant impact on man or biota.

   d. Operation of the plant under the provisional operating license appears to have caused no environmental impacts more serious than those predicted in the FES. These are summarized in item 3 of the FES Summary and Conclusions.

4. The following Federal, State and local agencies have been requested to comment on the Draft of this addendum:

   Advisory Council on Historic Preservation
   Department of Agriculture
   Department of the Army, Corps of Engineers
   Department of Commerce
   Department of Health, Education and Welfare
   Department of Interior
   Department of Transporation
   Environmental Protection Agency
   Federal Energy Administration
   Federal Power Commission
   State of Michigan Department of Natural Resources
   State of Michigan Department of Public Health
   Covert Township Supervisor

5. This addendum was made available to the public, to the Council on Environmental Quality, and to other specified agencies in November 1976.

6. On the basis of the analysis and evaluation set forth in this addendum, and after weighing the environmental, economic, technical and other benefits of the plant against environmental costs and considering available alternatives, it is concluded that the action called for

under NEPA and 10 CFR Part 51, is the issuance of a full-term operating license for the Palisades Nuclear Power Plant at a power level of 2638 MWt, subject to the following conditions for the protection of the environment:

(A) License Conditions:

(1) Before engaging in an operational activity not evaluated by the Commission, the applicant shall prepare and record an environmental evaluation of such activity. When the evaluation indicates that such activity may result in a significant adverse environmental impact that was not evaluated, or that is significantly greater than that evaluated in the FES as supplemented by this addendum, the applicant shall provide a written evaluation of such activities and obtain prior approval of the Director, Office of Nuclear Reactor Regulation for the activities.

(2) If unexpected harmful effects or evidences of serious damage are detected during plant operation, the applicant shall provide to the staff an acceptable analysis of the problem and a plan of action to eliminate or significantly reduce the harmful effects.

(3) The applicant shall follow the precautions, for transmission right-of-way maintenance, prescribed in Section 5.3.34 of this addendum and the recommendations, for grounding objects beneath the 345-kv line, in the same section.

(B) Technical Specification Requirements:

The present environmental technical specifications shall be expanded to include the environmental monitoring programs recommended in Section 6 of this addendum.

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FOREWORD

This addendum was prepared by the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, in accordance with the Commission's regulation, 10 CFR Part 51, which implements the requirements of the National Environmental Policy Act of 1969 (NEPA).

The NEPA states, among other things, that it is the continuing responsibility of the Federal Government to use all practicable means, consistent with other essential considerations of national policy, to improve and coordinate Federal plans, functions, programs, and resources to the end that the Nation may:

- Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations.
- Assure for all Americans safe, healthful, productive, and aesthetically and culturally pleasing surroundings.
- Attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences.
- Preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment which supports diversity and variety of individual choice.
- Achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities.
- Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

Further, with respect to major Federal actions significantly affecting the quality of the human environment, Section 102(2)(C) of the NEPA calls for preparation of a detailed statement on:

(i) the environmental impact of the proposed action,

(ii) any adverse environmental effects which cannot be avoided should the proposal be implemented,

(iii) alternatives to the proposed action,

(iv) the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and

(v) any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.

An environmental report accompanies each application for a construction permit or a full-power operating license. A public announcement of the availability of the report is made. Any comments by interested persons on the report are considered by the staff. In conducting the required NEPA review, the staff meets with the applicant to discuss items of information in the environmental report, to seek new information from the applicant that might be needed for an adequate assessment, and generally to ensure that the staff has a thorough understanding of the proposed project. In addition, the staff seeks information from other sources that will assist in the evaluation, and visits and inspects the project site and surrounding vicinity. Members of the staff may meet with State and local officials who are charged with protecting State and local interests. On the basis of all the foregoing and other such activities or inquiries as are deemed useful and appropriate, the staff makes an independent assessment of the considerations specified in Section 102(2)(C) of the NEPA and 10 CFR 51.

This evaluation leads to the publication of a draft environmental statement, prepared by the Office of Nuclear Reactor Regulation, which is then circulated to Federal, State, and local government agencies for comment. A summary notice is published in the Federal Register of the availability of the applicant's environmental report and the draft environmental statement. Interested persons are also invited to comment on the draft statement. Comments should be addressed to the Director, Division of Reactor Licensing, at the address shown in the last paragraph of this Foreword.

After receipt and consideration of comments on the draft statement, the staff prepares a final environmental statement, which includes a discussion of questions and objections raised by the comments and the disposition thereof; a final benefit-cost analysis, which considers and balances the environmental effects of the facility and the alternatives available for reducing or avoiding adverse environmental effects with the environmental, economic, technical, and other benefits of the facility; and a conclusion as to whether--after the environmental, economic, technical, and other benefits are weighed against environmental costs and after available alternatives have been considered, the action called for, with respect to environmental issues, is the issuance or denial of the proposed permit or license, or its appropriate conditioning to protect environmental values.

The Final Environmental Statement Related to Operation of the Palisades Nuclear Generating Plant (the FES) was issued in June 1972. In September 1972 the Provisional Operating License for Palisades (DPR-20) was issued. On January 22, 1974, Consumers Power Company requested conversion of DPR-20 to a Full-Term Operating license and applied for an increase in maximum authorized steady-state core power level from 2200 megawatts thermal (MWt) to 2638 MWt. This addendum supplements the FES by addressing new information and changes in staff evaluation or plant design. The FES and this addendum together constitute the environmental impact statement for the license conversion and power increase, satisfying the requirements of 10 CFR §51.5.

Effective January 19, 1975, activities under the U.S. Atomic Energy Commission regulatory program were assumed by the U.S. Nuclear Regulatory Commission in accordance with the Energy Reorganization Act of 1974. Any references to the Atomic Energy Commission (AEC) contained herein should be interpreted as Nuclear Regulatory Commission (NRC).

Single copies of this addendum may be obtained from and comments should be addressed to the Office of Nuclear Reactor Regulation, Nuclear Regulatory Commission, Washington, D.C. 20555. If there are any questions regarding the contents of this addendum, the NRC Environmental Project Manager, Dr. P. C. Cota, may be contacted (301-443-6950).

1. INTRODUCTION

1.1 APPLICATION FOR FULL-TERM OPERATING LICENSE

On January 22, 1974, Consumers Power Company (the applicant) requested conversion of Provisional Operating License No. DPR-20 for Palisades Nuclear Power Plant Unit No. 1 to a Full-Term Operating License (FTOL). At the same time, the applicant applied for an increase in maximum authorized steady-state core power level to 2638 megawatts thermal (MWt).

1.2 APPLICATIONS AND APPROVALS

Since issuance of the Final Environmental Statement Related to Operation of Palisades Nuclear Generating Plant (FES) in June 1972, several applications have been filed by the applicant. Following is a history of these applications and approvals received.

Permit	Status
Provisional Operating License (U.S. Nuclear Regulatory Commission)	Issued on 9/1/72, amended 16 times thereafter.
Full-Term Operating License (USNRC)	Pending
Building Permit for Cooling Towers (Covert Township)	Issued
National Pollutant Discharge Elimination System Permit (Michigan Department of Natural Resources)	Issued 8/2/76
Permit to Place Offshore Riprap (U.S. Army Corps of Engineers)	Pending

1.3 PURPOSE AND SCOPE OF THIS ADDENDUM

The FES analyses of radiological impact, need for power, and alternatives assume a rated power of 2200 MWt (corresponding to an electric output of approximately 700 MWe). The applicant seeks to operate the plant at up to 2638 MWt, corresponding to an increase of 100 MW in electric power output. This addendum revises those portions of the FES that do not reflect the increased power levels.

As three years have elapsed since publication of the FES, this addendum also considers information not available when the FES was prepared, and revises the analyses as appropriate.

Based on the revised analyses in this addendum, appropriate agency action is recommended.

2. THE SITE AND RELATED MONITORING RESULTS

RÉSUMÉ

The staff has revisited the site to determine if there have been any significant changes at the Palisades site which would alter the staff's evaluation presented in the FES. New land use information and monitoring results have been evaluated by the staff since issuance of the FES and are addressed in this addendum. Otherwise, the Section II discussion in the FES is still valid.

Due to the limited operation of the plant thus far, data gathered in the environmental monitoring program have been insufficient to establish whether adverse impacts would have resulted from operation of the plant. Results of monitoring that has been conducted are discussed in this section.

2.1 REGIONAL DEMOGRAPHY

The sections in the FES pertinent to regional demography are complete and require no additions or changes.

2.2 SITE ECOLOGY AND ENVIRONS

2.2.1 Aquatic Biota

This section summarizes the results of the monitoring programs conducted during the time that the plant was operating with once-through cooling. The results of the pre-operational sampling which was conducted from 1968 to 1971 are compared with data obtained during the operational years 1972 and 1973. Predictions were made in the FES[1] concerning the results of operational monitoring programs. Differences in environmental effects from those predicted in the FES are evaluated.

Preoperational lake studies were begun in May 1968 and conducted four times a year (May, June, August and October) until October 1971. Lake sampling was conducted twice in 1972 (June and October), but was returned to preoperational frequencies in 1973. Sampling was conducted during June and August in 1974. An additional survey was scheduled for October 1974, but was abandoned due to adverse lake conditions. Surveys relating to plant operation were conducted more frequently during the period of once-through cooling. The overall biological sampling station grid is shown in Figure V-4 of the FES.

The primary biological parameters measured during the study were benthos diversity and density; plankton species density, productivity and mortality; fish abundance by species; and impingement on the traveling screens of the power plant. Studies were also made of psammolittoral organisms inhabiting the shoreline and periphyton growth on artificial substrates.

Plant operation was not continuous nor at 100% power during the operational monitoring programs.

The applicant summarized the work at the plant in "Summary of the Effects of Once-Through Cooling at the Palisades Nuclear Power Plant."[2] Additional data were provided in the Environmental Report for the Full-Term Operating License,[3] Progress Reports on Pre-Operational Biological Studies of Lake Michigan in Connection with Consumers Power Company Palisades Plant near South Haven, Michigan,[4] and Semiannual Operating Reports 4 - 8.[5-10]

Phytoplankton

Phytoplankton standing crop was sampled throughout the study period by determining packed cell volume (PCV). The average packed cell volumes from 1968 through 1974 showed substantial variations. Even before station operation, in August 1968 and May 1971, significant differences in standing crop already had occurred between the Palisades and control sampling stations. However, overall seasonal trends were similar at the Palisades and the control stations. Variations of PCV at both control and heated plume stations increased as the average PCV increased. Spatial and temporal variations in PCV were such that they could not be attributed to plant operation.

The phytoplankton composition was dominated by diatoms. Blue-green and green algae were not abundant. Tabellaria, Asterionella, Fragilaria, Cyclotella, Melosira, and Synedra, were dominant genera at one time or another. Other commonly occurring genera were Navicula, Rhizosolenia, Scenedesmus, Pediastrum, Dinobryon, and Oscillatoria.

Collections of phytoplankton were made at the intake and discharge to determine entrainment effects. Relative photosynthetic rates were measured by the C^{14} method. Fifty-two sets of experiments were performed on 25 separate occasions from May 24, 1972 to August 27, 1973.

The effects of condenser passage on productivity rate were highly variable. In many instances productivity increased after passage. However, if the samples are analyzed collectively for the entire study period productivity decreased 33% in the heated discharges and 18% in the nonheated discharges. Large decreases in photosynthetic activity and no increases were seen during summer months when the discharge temperature exceeded 90°F.

The Palisades FES predicted that shifts in phytoplankton species composition to undesirable blue-green algae were unlikely. Subsequent monitoring bears this out and only occasional and minor changes in species composition were seen in the discharge canal samples. The same groups were dominant at control and discharge stations.

The FES further predicted that a small percentage of cells would be killed by mechanical damage during plant passage and that photosynthesis would be decreased during ambient temperatures. As indicated above approximately 18% of the phytoplankton were killed by mechanical damage during plant passage. Reductions in photosynthetic activity were common in the discharge canal during the summer.

In summary, the results of the monitoring program verify the FES prediction that distribution, abundance, and productivity of the phytoplankton of Lake Michigan would suffer no significant impact because of the once-through operation of the Palisades Plant.

Periphyton

Periphyton samplers were installed in 15 ft of water at the north and south boundaries of the plant and opposite the outfall. Growth rate of periphyton was low ranging from 0.1 to 5.33 $\mu g/cm^2$/day during 1970 to 1971. Little relevant information resulted from the study because natural hard substrates are uncommon near the site. Hard surfaces are provided by the intake and outfall structures. This study was terminated before plant operation because of the difficulty in maintaining and retrieving the samplers.

Attached Algae and Rooted Aquatics

The lake bottom near the plant was surveyed for attached algae and rooted aquatics in October 1972, and September and October 1973. Surveys were conducted by divers swimming transects perpendicular to the shoreline.

No algae or rooted plants were observed on the substrate. The site area is predominately sandy gravel which is too unstable to allow plants to attach and root. Large amounts of free-floating filamentous algae became entangled in the seine nets during June 1971 and in gill nets during August 1971. However, on both occasions it was apparent that the material did not originate in the plant vicinity.

No impact of once-through cooling on filamentous algae was predicted in the FES. However, it was indicated that plant induced patterns of water circulation could promote accumulations of masses of detached filamentous algae, primarily Cladophra, on nearby beaches. No large accumulations were noted during shoreline surveys.

Zooplankton

Field samples of zooplankton were taken concurrently with the phytoplankton samples. Zooplankton were collected from depths of 15 to 5 feet and filtered through a #25 plankton net.

The most abundant groups were the cyclopoid and calanoid copepods and the Bosmina cladocerans. Bosmina was particularly dominant in the summer months. Other dominant cladocerans were Diaptomus, Limnocalanus, Asplanchna and Daphnia.

Population densities of the various groups fluctuated little from year to year. Zooplankton density typically increased in the fall and spring. Zooplankton density was greater in June 1974 than in June of the previous two years.

Samples were collected from the intake and outfall to determine passage mortality. The intake bay was sampled and approximatly 90 seconds later the discharge was sampled. It was assumed that the intake and discharge samples represented the same water mass. Sampling consisted of pouring 50 to 200 quarts of water from the intake or discharge through a #10 mesh Wisconsin plankton net while the net was submerged in a bucket of water. The zooplankton were incubated for 4-1/2 hours at the intake temperature.

Staining was used to distinguish live from dead organisms. Ratios were then calculated for live to dead organisms at the intake and at the discharge locations.

Entrainment mortalities were determined for dominant groups of zooplankton organisms. Large variations are usually encountered when conducting this type of sampling. Plankton patchiness, sampling variability, mortality errors, and many other factors allow only gross estimates. Calanoid copepods experienced an average mortality of 15%, of which approximately 6% was due to mechanical effects. Cyclopoid copepods had an average mortality of 7% of which 6% was due to mechanical effects. The cladoceran Bosmina had an entrainment mortality of 6%, which was primarily from mechanical damage. Rotifers suffered 12% mortality of which more than half was mechanical damage. Discharge temperatures exceeding 90°F cause nearly 100% mortality, indicating that this is the upper lethal temperature level for entrained zooplankton.

Analytically valid comparisons between the field sampling and the entrainment mortality data are impossible because sampling schedules were not coordinated, different mesh net sizes were used, and different depths were sampled. The population densities of Bosmina and the rotifers were different in the two studies. Both organisms were more abundant in the field samples than in the intake samples. It appears that the difference was caused by a variation in density with depth.

The FES for Palisades indicated that possibly about 30% of the zooplankton would be killed by passage through the power plant. The monitoring program indicated that less than 15% were killed. The monitoring study, however, did not examine any effects more than 4.5 hours after passage. Mortality after two or three days could be greater.

The FES stated that changes in species composition were possible if there were selectively greater mortality to some forms, particularly the larger species. As previously stated, the field and entrainment studies are not comparable so this question cannot be answered definitively. Overall, however, the FES considered the impact on zooplankton in Lake Michigan to be insignificant. Information developed by the monitoring program does not indicate otherwise.

Psammolittoral Organisms

The study of psammolittoral organisms (those living at the water's edge) was undertaken in June and October, 1972 and 1973. Nine cores, three taken on shore two feet above the waterline, three at the waterline, and three at two foot water depth, were taken at each of the 12 stations situated along the beach north and south of the plant discharge. Total counts of organisms indicated greatest abundance in the cores taken from above the waterline. The highest counts were in June 1972 and October 1973. The dominant organisims which could be identified were diatoms, other algae, protozoans, rotifers, oligochaetes and nematodes. Comparison of organism density at the various stations did not reveal any relationships with distance from the plant or any plant related abnormal variability.

Benthos

Samples of the bottom fauna were obtained by means of a 0.54 ft^2 Ponar grab.

Replicate samples were taken at each station on the fixed sampling grid (Figure V-4 of the FES). Initially, six samples were taken at each station, but this was reduced to three in 1969, when statistically justified on the basis of population means and diversity.[5]

Samples were taken four times a year (May, June, August and October) from 1968 through 1971. Additional stations were included at the 20- and 10-foot depths north and south of the plant and at the north and south controls as a result of recommendations of the Atomic Energy Commission.[1]

Sampling occurred only in June and October in 1972 but previous frequencies were resumed in 1973. The 1974 survey for benthos was smaller than the full scale surveys of previous years. Only stations where changes in population densities had been found were sampled, and only those organisms involved in the changes were studied.

The applicant summarized the four years of preoperational conditions in its fourth semiannual operating report.[6] The findings of the preoperational studies were in agreement with work by other authors on the benthic organisms to be found in the shallower regions of Lake Michigan.[11-13] Four major groups of organisms encountered were: Chironomidae (midges), Sphaeriidae (fingernail clams), Amphipods (scuds, represented by one species, Pontoporeia hoyi), and Oligochaeta (segemented worms).

As the other groups of organisms were represented by only a few individuals and were usually found infrequently, only the four groups were used in the mathematical analysis of the data.

The inshore, wave disturbed, areas were very sparsely populated; the dominant organisms were midges. The midges in the study area were in the Subfamily Chironominae (Chironomus, Cryptochironomus and Cryptotendipes) with subdominants in S.F. Orthocladinnae (Psectrocladius and Heterotrissocladius and S.F. Tanypodinae (Procladius). Occasionally clams, snails, worms, leeches and amphipods were also present.

The dominant genera within the midges changed with depth; Chironomus was dominant to 15 ft., Chironomus and Cryptochironomus co-dominant to 30 ft. and the latter to 50 ft. Beyond this depth, Prodiamesa Procladius and Heterotrissocladius were dominant to 98 ft.

Samples taken from deeper water show the depth dependence of the other organisms. The clams, represented by Pisidium and Sphaerium and an amphipod, Pontoporeia hoyi became more numerous with increasing depth. P. hoyi was co-dominant with the worms at the deepest stations sampled.

Seasonal fluctuations in the benthic populations were found at all stations. No definite trend was evident for any specific group based on total counts, average numbers per square foot, or diversity indices. Diversity indices for the whole study area ranged between 0.189 for Station A-1 in October 1971, to 2.286 at the same station in June 1969, indicating a fairly undiversified benthic population typical of sandy sediments which are normally low in productivity. The low values could also be caused by large numbers of one group in the population. The indices did not necessarily increase with depth nor were they all greatest in June or in October.

A novel statistical approach was used to compare pre-operational conditions to operational conditions. The method uses "control charts", in combination with bivariate distributions.[6] The bivariate distribution uses the data from areas outside the immediate influence of the discharge to cancel the effect of normal population variations. Operational results are plotted on the bivariate control charts to compare the densities and biomass of the four major benthic groups and the total diversity of all organisms to these parameters before plant startup.

The control charts are based on the premise that four years of baseline surveys adequately describe the biological variability of the benthos. The months of June and October for the years 1968 through 1974 were used for the comparisons. As noted previously, the distribution of benthos in the lake is significantly depth dependent. Thus, only stations at similar depths were used as control and "affected" stations in the analysis.

The control charts indicated that many stations may have been affected by the thermal discharge. Table 2.1 summarizes the significant changes in density and diversity as shown by the bivariate control charts. Little correlation is shown between the number of stations affected and the distance from the discharge. If the discharge was directly related to the community changes, the number of stations affected should increase as the distance from the discharge decreased. It should be noted that only four 5-mile stations were sampled and changes occurred at all of them even though the plume normally would not extend that far and that deep (>50 ft).

TABLE 2-1[2]

SIGNIFICANT CHANGES IN BENTHIC POPULATION

Distance from Discharge (miles)	Number of Stations with Significant Changes in The Benthic Population	Total No. of Stations
> 5	3	4
5	4	4
2	6	6
1	5	6
0.5	6	7

The control chart method detected significant changes in the benthos that further investigation proved to be due to unusually wide natural variations. This fact demonstrates the invalidity of the major premise that the four years of baseline surveys adequately describe the natural variability. The benthos in the lake are in a continuous state of change and alteration even under conditions free of man-induced environmental stress. This extreme variability has also been found at the Cook Plant about 30 miles south of Palisades. Investigators there estimated that the ratio of average population at the inner stations (near the discharge) to the average of the control stations would have to change by a factor greater than 5 to be attributable to plant operation.[14]

Some changes were noted in the immediate discharge area. These decreases were believed to have resulted from silt deposition during construction and initial plume scour rather than increased temperature alone.

The FES predicted that effects on benthic invertebrates from thermal discharges and plume scouring would be localized in the immediate area of the outfall and would have negligible impact on the overall benthic populations.

The conclusion of the benthic sampling program is that few direct discernible thermal effects were detected in the sampled communities. Some significant increases and decreases have occurred in some major groups but they are not concentrated in the discharge area and probably are attributable to the general instability of the benthic communities in this region.

Fish

The Michigan Department of Natural Resources conducted preoperational surveys of the fish stocks in Lake Michigan near the Palisades Nuclear Power Plant beginning in the summer of 1968 until October 1973. These surveys continued when the plant was operational. Comparative data from within and outside the heated discharge plume were obtained only five times; including only two at 100% power.

A total of forty species of fish were captured using gill net, seine, and trawl techniques. The dominant species in the gill net catch were alewives (53.2 percent) and perch (40.0 percent). The seine catch was dominated by alewives, spottail shiners, longnose dace, and trout-perch, and the trawl catch by smelt (shallow zones) and bloaters (deeper zones).

Gill net catches of perch and alewives, the two most numerous species, were compared statistically for the periods before and after plant startup. No significant difference could be demonstrated at the 90 percent level of confidence. In an attempt to determine the effect of the thermal plume on species distribution, a paried 't' test was used to compare catches of the four most numerous species caught both in and out of the plume. No significant differences could be demonstrated. Species tested were yellow perch, alewife, longnose sucker, and white sucker.

Seine catches of spottail shiners, longnose dace, and trout-perch were also statistically (paired 't' test) compared to determine if a change in the inshore populations had occurred following the introduction of the thermal discharge in 1972. No significant differences were found in the mean catches. Changes in catch had occurred, but variability was such that a change of 50 to 60 percent was required in order to be significant.

Smelt, alewife, and trout-perch dominated the trawl catches; however, the data were not sufficient for the results to be related directly to plant operation.

The spawning period for approximately 1/3 of the perch collected in gill nets in the vicinity of the plant in 1973 appeared to have been advanced by as much as three to four weeks, from the normal early-June period, to mid-May. It was suggested that this advanced spawning period was a reflection of the warmer spring water temperatures due to the thermal discharge from the plant. However, sample sizes for all years were very small and May samples were not collected in 1971 and 1972. The 17 fish which had spawned in May 1973 may not be representative of the overall population and could have come from inshore areas where spawning is known to occur earlier. Wells (1973) in his collections of fry in 1972 along the nearshore waters of southeastern Lake Michigan found perch fry as early as May 6. He indicated that these fry came from perch which had spawned earlier in the tributaries to Lake Michigan. He postulated that fry collected north of the Palisades site may have come from early spawning in the nearby Kalamazoo River. The spawned fish at Palisades, therefore, may have been fish which had spawned in inshore tributaries rather than in the thermal plume.

Samples of salmonids taken in and out of the plume indicated that lake trout and brown trout may have been attracted to the plume, whereas salmon were not. Sample numbers, however, were very small. Due to the seasonal nature of the sampling program, the presence or absence of fish species between late October and early May was not monitored.

Water temperatures along the beach, as monitored by the Michigan Department of Natural Resources during their seining operations over the six year period, were not noticeably greater during plant operation in 1972. Data indicate that all 1972 seining temperatures were equalled or exceeded in preoperational years at comparable times of the year. On the other hand, 1973 night-time temperature maximums along the beach seining area did exceed previous maximums by 4° to 9°F (2.2° to 5°C).

Consumers Power Surveys

Consumers Power Company fishery surveys during 1972 and 1973 included seine, trawl and gill net sampling.

Seining operations were performed at five areas along the shoreline. Seining operations at stations in heated water yielded considerably higher catches than at stations in non-heated zones. It was concluded that the warm discharge water attracted and concentrated alewives, carp, spottail shiner, trout, salmon, and various centrachids. Large numbers of alewife, carp and spottail shiner were seen in the discharge canal. Fish left the discharge as temperature preferenda were exceeded.

Largest catches were obtained directly off the discharge point, whenever there was a discharge, either heated or non-heated. Smelt and alewives were the prominent species. Trawls were at the 10-foot depth, under the direct influence of the plume. The largest trawl collections were obtained where the water was more turbid, indicating this method of fish collection may not have captured representative samples of the fish populations. Seining similarly may not capture representative samples.

Additional gill net data were collected during 1973 from the general discharge area and the immediate vicinity of the discharge. The data were organized according to species caught and the water temperature at the time of fishing. Nets set in different temperature ranges indicated that perch were tolerant of temperatures up to 90°F (32.3°C) and possibly higher. The range up to about 70°F (16°C) appeared to be the maximum tolerable limit for the salmonids, which indicated a preference for the 50° to 60°F (10° to 16°C) range. The gill net data, together with seine and trawl data, indicate that many fish species which normally occur in the area off the Palisades Plant inhabited the area of the discharge at some time during the year. The reason for the attraction of these fish to the discharge may have been temperature and/or current, but the attraction seemed definite.

The discharge, because of its attractiveness to fish, provided an active sport fishery during spring, early summer and fall. The effects of the plant on the life cycles of 16 important fish at the Palisades site are contained in the applicant's "Summary of the Effect of Once-Through Cooling at the Palisades Nuclear Power Plant." There were no indications that the plant operation was having a detrimental influence on the local populations of these species.

Impingement

Fish and crayfish impinged on the plant intake traveling screens have been monitored at least once per day since January 23, 1972. The basic procedure was to run the screens automatically every 12 hours and count the organisms that are washed off the screens and sluiced into a collection basket. Fish were identified, counted, and weighed.

Between January 23, 1972 and October 25, 1973, a total of 653,890 fish were impinged. This number of fish weighed approximately 43,806 lbs. Alewives made up 58.6 percent of the total; slimy sculpins, 27.5 percent; spottail shiners 7.2 percent; and perch 4.2 percent. From June 30, 1973 to October 25, 1975, 3,508 crayfish were impinged, the largest number during any semiannual reporting period.

The total numbers and percentages of each species and the periods of greatest impingement are shown in Table 2.2. Few game fish were impinged: 158 salmonids, 553 coregonids, 7,633 smelt and 18 pike. Over 50 percent of the fish were physically damaged after impingement.[2]

Major impingement of adult alewives occurred in the sping and fall at the times of their seasonal inshore-offshore migrations. The slimy sculpin was the second most abundant fish impinged on the traveling screens. The rip-rap around the base of the intake crib provided good habitat which may account for the presence of these fish on the screens. Very few sculpins were taken by seine, trawl or gill net. The peak abundance during March, April and May is probably related to their inshore spring spawning period.

The Palisades FES prediction that spottail shiner would be impinged because of its normal distribution near the intake crib was verified. Peaks occurred during early spring and late fall.

TABLE 2.2[2]

TOTAL NUMBER OF FISH COLLECTED FROM TRAVELING SCREENS
FROM 23 JANUARY 1972 TO 25 OCTOBER 1973

SPECIES	TOTAL NUMBER	(%)	PERIOD OF GREATEST IMPINGEMENT
Sea lamprey	1	(<1.0)	-
Gizzard shad	9	(<1.0)	-
Alewife - young	42,565	(6.5)	October, 1972; October, 1973
- adult	340,774	(52.1)	April, 1973
Cisco	3	(<1.0)	-
Steelhead	16	(<1.0)	Spring
Coho salmon	26	(<1.0)	May-June, 1972 and 1973
Chinook salmon	29	(<1.0)	June-July, 1973 (young)
Lake trout	86	(<1.0)	January-March, 1973
Lake whitefish	28	(<1.0)	August, 1973
Round whitefish	1	(<1.0)	-
Brown trout	1	(<1.0)	-
Bloater	521	(<1.0)	May-August, 1972 and 1973
Smelt - young	874	(<1.0)	June-August, 1973
- adult	6,759	(1.0)	April-May, 1973
Northern pike	18	(<1.0)	October, 1973
Central mudminnow	1	(<1.0)	-
Carp	17	(<1.0)	Winter
Longnose dace	5	(<1.0)	-
Spotfin shiner	1	(<1.0)	-
Spottail shiner	46,897	(7.2)	October-April, 1973; *Dec.(esp.)
Lake chub	3	(<1.0)	-
River chub	2	(<1.0)	-
Northern redhorse	1	(<1.0)	-
White sucker	395	(<1.0)	December-January, 1973
Longnose sucker	1,294	(<1.0)	June, 1973
Channel catfish	168	(<1.0)	December-January, 1973

TABLE 2.2 (Continued)

SPECIES	TOTAL NUMBER	(%)	PERIOD OF GREATEST IMPINGEMENT
Yellow bullhead	2	(<1.0)	-
Black bullhead	76	(<1.0)	April-June, 1972
Trout-perch	3,485	(<1 0)	April-June, 1973; May, 1972
Burbot	513	(<1.0)	December-March, 1973
Nine-spine stickleback	409	(<1.0)	April-June, 1972, 1973
Slimy sculpin	180,303	(27.5)	March-April-May
Rock bass	1	(<1.0)	-
Pumpkinseed	2	(<1.0)	-
Bluegill	5	(<1.0)	-
Perch - young	1,084	(<1.0)	October-December, esp. Dec. 1972
- adult	27,433	(4.1)	May-June, 1972, 1973
Logperch	1	(<1.0)	-
Johnny darter	27	(<1.0)	May, 1972, 1973
Bowfin	54	(<1.0)	February-May, 1972
Total	653,890		

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Assuming a uniform fish density of 25 pounds/acre, the FES predicted that about 60,000 pounds of fish would be impinged per year. In the screen monitoring program the maximum 12 month period resulted in a collection of less than 37,000 pounds. However, during the three months of March, April and May about 26,000 pounds were impinged even though plant operation during this period was at slightly less than 100%. During much of the rest of the year the plant operated at much less than full power. If the numbers impinged during the rest of the year are extrapolated to full-power (flow) operation, then the original estimate may be a reasonable maximum.

Entrainment of Fish Eggs and Larvae

The intake water was periodically monitored in 1972 and 1973 for fish eggs and larvae using plankton nets and pumps. Of the eggs collected, most were unfertilized. It is possible that some of the eggs were expelled by fish entrapped in the intake. Thirty-six larvae were collected from the intake and represented the following species: smelt (13), sculpin (9), alewife (12), and perch (2). During one sampling period over 4 eggs/m^3 were collected at the intake. The identity of the eggs was not known.

Sampling for fish eggs and larvae, however, was not adequate to establish the seasonal density and mortality of the important species at the Palisades site. Prediction made in the FES relating to entrainment effects on fish populations, therefore, cannot be verified.

2.2.2 Terrestrial Ecology

Most of the impacts on terrestrial systems have already occurred as a result of construction of this station. Discussion can be found in the FES. Construction of mechanical-draft cooling towers has disturbed slightly over one acre of a mixture of blow-out area vegetation and early successional stage forest. The applicant indicates that the blow-out area was sparsely vegetated with beach grass, wormwood, milkweed, evening primrose, goldenrod, mullein, hoary puccoon, broom sedge, summer grape, dogwood and sand cherry. Species in an area of early successional stage forest include sassafras, red oak, white ash, basswood, black cherry, choke cherry, juneberry, summer grape, false Solomon's seal, goldenrod, sedge, aster and various grasses.

2.2.3 Water Quality and Plant Chemical Releases

Detectable, unacceptable changes in the quality of the receiving waters in the vicinity of the Palisades Nuclear Generating Plant were not anticipated at the conclusion of the staff's environmental review conducted during the Provisional Operating License review (FES). Table III-10 of the FES, here reproduced as Table 2.3, indicates negligible expected increases over the background concentrations of various chemical species in the effluent released by the plant, with the exception of boric acid and residual chlorine. These two constituents had been identifed in the FES as having the greatest potential for altering water quality and affecting aquatic biota.[1] The analysis presented in the FES is still valid with respect to the potential impact of boric acid and residual chlorine and the staff is in agreement with the FES prediction of no detectable population impact as a result of the release of the other chemicals as predicted in Table 2.3.

The staff has reviewed the Semiannual Operational Monitoring Reports for the period of 1972 through 1974.[5-10-16] Examination of these data indicates that the applicant has not chlorinated the main circulating water system through the period ending December 31, 1974. The service water system was chlorinated for three separate 10-minute periods and one 30-minute period, all occurring on May 26, 1973. No measurements of actual total residual chlorine achieved in the system have been provided; however, neglecting chemical reduction to chloride, the calculated total residual chlorine in the plant discharge was 2.1 ppm for all chlorination periods. No detectable total residual chlorine was found in the discharge from the plant immediately downstream of the service water outfall when measured by amperometric titration.

The large variability in chlorine demand of Lake Michigan waters (ranging from 0.15 ppm to 1.3 ppm in 70 minutes demand tests conducted by the applicant during 1972 and 1973) plus the demand of organic growths in the service water system could easily account for this observation.

TABLE 2.3

MAXIMUM CONCENTRATION IN PARTS PER MILLION OF CHEMICALS IN CIRCULATING WATER DISCHARGE CANAL[a]

Chemicals Regenerated	Ave. Conc. of Lake Michigan Water, ppm	Conc. Added to Lake From Demin, Process, ppm	Conc. Added to Lake From C.T. Blowdown ppm	Cir. Water Dis. to Lake Michigan Initial Opr.[b] ppm	Cir. Water Dis. to Lake Michigan Modified Opr.[c] ppm	Recommended Limits of Conc. in Drinking Water, ppm	Drinking Water in 100 Largest Cities Median, ppm	Drinking Water in 100 Largest Cities Maximum, ppm
Cl	9.0	0.003	1.7	9.0	10.7	250	13	540
Fe	0.1	0.00003	0.02	0.1	0.1	0.3	0.02	1.3
SiO_2	2.1	0.0004	0.4	2.1	2.5		7.1	72
Mn	0.02	0.000006	0.004	0.02	0.02	0.05	0	2.5
Ca	33.6	0.011	6.5	33.6	40.1	7.5	26	145
Mg	11.2	0.003	2.2	11.2	13.4	50	6	120
CO_3	6	0.002	1.2	6.0	7.2		0	26
HCO_3	14.3	0.034	1.4	14.3	15.7		46	380
SO_4[d]	22.2	0.131	26.7	22.3	48.9	250	26	572
Na[e]	10.6	0.082	2.1	10.7	12.7	250 (TDS)	12	198
PO_4[e]	0.013	0	0.26	0.013	0.27			
H_3BO_3[e]	0	0	0	5	0	1.0		
Zn	0.010[f]	0	0.026	0.01[f]	0.036			
Residual Chlorine[e]	0	0	0.022	0.5	0.022			

Note: The discharge will have a pH between 6.5 and 9.5.

[a]Discharges will be intermittent; values given here are the maximum concentrations.

[b]Once-through cooling and present radwaste systems in operation. Concentrations include the average concentration of Lake Michigan water and the chemicals from the demineralizer regeneration process discharged at 20 gpm into 405,000 gpm cooling discharge water. See Table III-9.

[c]After installation of cooling towers and modified radwaste system. Concentrations include the average lake water concentration and the concentrations added to the lake from the cooling tower blowdown.

[d]Chemicals released from demineralizer regeneration.

[e]These chemicals are also present in the condenser cooling water but are released through other Plant operations.

[f]Rosaman, R. and Callendar, E., "Geochemistry of Lake Michigan Manganese Modules," Proc. 12th Conf. Great Lakes Research, 1969, pp. 306-316.

Chlorination activities during 1974 are contained in the applicant's Monthly Operating Reports submitted to the State of Michigan Water Resources Commission. A single chlorination of the plant's systems was performed on September 20, 1974 in which the total residual chlorine released from the system was a maximum of 0.25 mg/l for a time period of approximately one minute. More substantial chlorinations were performed during the periods of October 9, 1974 through October 16, 1974 and October 28, 1974 through October 31, 1974. These chlorinations were limited to one-half hour each day in which the cooling tower system was chlorinated and none of this waste was discharged to the Lake.

Releases of boric acid at a concentration of 5 ppm from primary coolant system leakage have been discontinued through implementation of a modifed radwaste treatment system by the applicant. As expected, no effects from the release of boric acid at the previous level have been detected.

The pH of the plant effluent has been monitored during 1974 and reported in the Monthly Operating Reports submitted to the State of Michigan Water Resources Commission. These reports indicate that the pH has exhibited little fluctuation and has always remained within the range of 6.5 to 9.5.

In summary, the staff believes that the concentrations, magnitude and frequency of the liquid discharges from the plant were consistent with those used in the analysis presented in the FES and therefore the impacts will be within those predicted therein for the once-through operation of the plant.

2.2.4 Site Acoustic Environment

The applicant has conducted two baseline acoustic surveys of the Palisades Nuclear Generating Plant site and the immediate surroundings. The methodology and complete results are reported in References 17 and 18, and the sampling locations for both surveys are shown on Figure 2-1.

The initial survey was conducted on September 8, 1971 and recorded A, B and C weighted, unweighted and one-third octave band sound pressure levels for ten locations in and around the site. The recorded sound levels varied from a minimum of 38 dBA at a point adjacent to the U.S. Highway 31 side of the switchyard (pt. 4) to a maximum of 50 dBA at both the plant side of the switchyard and immediately adjacent to the plant itself (pts. 5 and 7, respectively). All three of these locations are on the site. Of interest are the sound pressure levels recorded at and beyond the site boundaries. In this survey, three such locations were sampled. The offsite location nearest the residential area south of the plant along the lake (pt. 10) yielded a sound level of 40 dBA. The boundary location at the intersection of U.S. 31 and the access road (pt. 1) had a level of 47 dBA while the boundary location near U.S. 31 and Van Buren State Park (pt. 6) had a level of 43 dBA.

This survey was conducted prior to startup of the plant and therefore reflects ambient acoustic conditions. These conditions were influenced by the traffic noise emanating from U.S. Highway 31.

An additional ambient sound pressure level survey was conducted on May 17, 1975 to provde an up-to-date characterization of the site and immediate vicinity.

This survey was conducted during both daytime and nighttime hours and sampled a total of 11 points. The recorded sound levels varied from 37 dBA (pt. 15) to 44 dBA (pts. 1 and 3) for the daytime period and from 35 dBA (pts. 1 and 11) to 55 dBA (pt. 7) for the nighttime period. The sampling locations of particular interest in the latter survey are the site boundary locations 1, 6, 11 and 17 and the offsite locations 12 and 15. The sound levels at these locations are shown on Table 2.4 for both daytime and nighttime sampling periods. These levels are the average of recorded levels taken during a time span of approximately one minute or less. Therefore, they must be considered to be instantaneous readings only and provide no information as to the background sound level (i.e., the L_{90} or sound level exceeded 90% of the time) nor the intrusion sound level (i.e., the L_{10} or sound level exceeded 10% of the time) at the site.

This later survey was also conducted during a period when the plant and cooling towers were not operating. This survey, like the first, reflects measurements strongly and continually influenced by the traffic on U.S. Highway 31 and Interstate Highway 196.

There are a total of seven sampling locations that were common to both sound level surveys. These are locations 1, 3, 6, 7, 8, 9 and 10/15. A comparison of the A-weighted sound levels recorded at these locations during the two surveys is given in Table 2.5. The two series of samples are independent and the small relative difference between the levels recorded indicates that there have been no significant changes in the site acoustic environment in the range of frequencies important in the A-weighting scheme and that the values recorded are indeed "typical"

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FIGURE 2-1

AMBIENT SOUND PRESSURE LEVEL SURVEY SAMPLING LOCATIONS

▲ - Sampling Location, 9/8/71 Survey

● - Sampling Location, 3/17/75 Survey

Reference: Palisades Research and Test Lab Report No. I-7A-750801

TABLE 2.4

AMBIENT SOUND PRESSURE LEVELS AT AND BEYOND SITE BOUNDARY ON 3/17/75

Sampling Location Identification No.	Daytime Sound Level, dBA re 2×10^{-5} N/m^2	Nighttime Sound Level, dBA re 2×10^{-5} N/m^2
1 (boundary)	44	35
6 (boundary)	40	39
11 (boundary)	38	35
12 (offsite)	42	40
15 (offsite)	37	38
17 (boundary)	41	39

TABLE 2.5

COMPARISON OF AMBIENT SOUND PRESSURE LEVELS IN TWO SITE SURVEYS

Common Sample Locations		Sound Level, dBA re 2×10^{-5} N/m^2		% Difference in Sound Levels
9/8/71 Designation	3/17/75 Designation	9/8/71 Survey	3/17/75 Survey	
1	1	47	44	- 6.4
3	3	45	44	- 2.2
6	6	43	40	- 7.0
7	7	50	-	-
8	8	46	40	-13.0
9	9	43	40	- 7.0
10	15	40	37	- 7.5

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of the site (i.e., the values may lie between the true background sound level, L_{90}, and the true intrusion sound level, L_{10}). However, the sound level data present instantaneous values only for these locations during both surveys. The staff has considered the ambient surveys conducted by the applicant with regard to the possible errors in measuring community sound levels using instantaneous or short duration sampling.[19-20] The staff concludes that the data cannot be quantitatively characterized in terms of distributive statistics (i.e., L_{10}, L_{50}, L_{90}, etc.), but the staff believes that the reported values may reasonably be considered to be "typical" of the site (as defined above) when the plant is not operating by virtue of the similarity of the independent survey results. However, little more useful information on the ambient site acoustic environment can be derived from the surveys, because the variety of sound sources (traffic, wind, waves, insects, etc.) at the site present a complex and unknown sound level frequency distribution.

2.2.5 Radiological Releases

The reported releases of radioactive materials from the plant prior to installation and operation of radwaste system modifications are given in Table 2.6.

The effective installation date for the plant's modified radwaste system was September 5, 1973. Releases after installation are given in Table 2.6.

TABLE 2.6

Radioactivity Releases in
Liquid and Gaseous Effluents
During Power Operation
(Ci/yr)[a]

Gaseous Effluent	1972[b]	1973	1974[c]	1975[cd]
Noble Gases	[illegible]05	454	0.03	747
I-131	0.0[illegible]87	0.29	0.01	0.3
Liquid Effluent				
Mixed Fission and Activation Products	6.8	24[b], 4[c]	5.3	0.1
Tritium	210	154[b], 31[c]	8.1	7.4

[a]Based on data from applicant's semiannual operating reports.

[b]Prior to modification of radwaste system.

[c]After modification of modified radwaste system.

[d]First six months of 1975.

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REFERENCES FOR SECTION 2

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2. Consumers Power Company, Summary of the Effects of Once-Through Cooling at the Palisades Nuclear Power Plant, May 1975.

3. Consumers Power Company, Palisades Plant Environmental Report for Full Term Operating License, Docket No. 50-255, Amendment 28 issued January 22, 1974.

4. Consumers Power Company, Progress Reports on Pre-Operational Biological Studies of Lake Michigan in Connection with Consumers Power Company Palisades Plant near South Haven, Michigan.

5. Consumers Power Company, Environmental Impact of Plant Operation Up To July 1, 1972, Special Report issued July 19, 1972.

6. Consumers Power Company, Fourth Semiannual Report of Operations, July 1, 1972 - December 31, 1972.

7. Consumers Power Company, Fifth Semiannual Report of Operations, January 1, 1973 -June 30, 1973.

8. Consumers Power Company, Sixth Semiannual Report of Operations, July 1, 1973 -December 31, 1973.

9. Consumers Power Company, Seventh Semiannual Report of Operations, January 1, 1974 -June 30, 1974.

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20. H. S. Safeer, "Community Noise Levels - A Statistical Phenomenon"; In: Journal of Sound and Vibration; Vol. 26, No. 4, pp. 489-502, 1973.

3. PLANT MODIFICATIONS

RÉSUMÉ

Design changes in the heat dissipation system and the chemical treatment system, beyond those addressed in the FES, are addressed in this section. In addition, the modified radwaste system described in the FES has been installed; the source terms have been recalculated for the higher power levels requested and are discussed in this section. Otherwise, the Section III discussion in the FES is still valid.

3.1 CONDENSER COOLING SYSTEM

3.1.1 General Description

In 1974 the once-through condenser cooling system was converted to cooling tower operation. The cooling towers are described in the FES. Figure 3-1 shows the appearance of the plant with the towers in place.

3.1.2 Design Changes in Heat Dissipation System

In March 1971 a settlement agreement was signed by representatives of the applicant and intervenors in the application for an operating license. One term of the agreement was for the applicant to change the condenser cooling system then installed in the plant (a once-through cooling system) to a condenser cooling system substantially conforming to the conceptual design shown in the upper half of Figure 3-2.

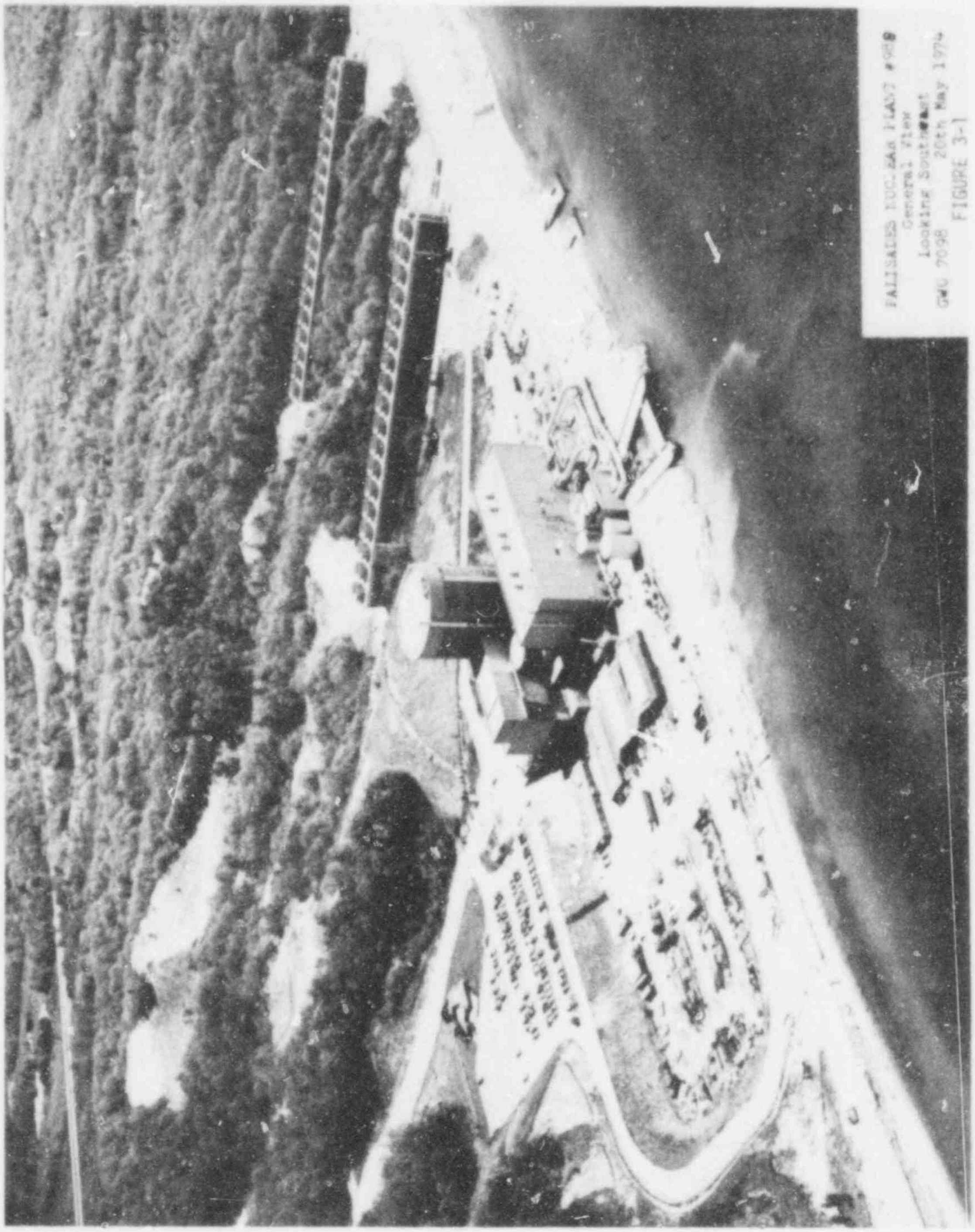
The lower half of Figure 3-2 shows the cooling system as constructed. The cooling water intake structure was modified so that the lake inlet goes only to the service water pump bay. The service water discharges into the cooling tower make-up basin. The circulating water pumps (now called the cooling tower pumps) now take water from the make-up basin and discharge to the cooling towers. Except for a small amount of cooling tower blowdown, the cooling towers discharge to the main condenser. The discharge mixing basin takes overflow from the make-up basin (equal in flow rate to that of the service water system), radwaste discharge, cooling tower blowdown, and dilution water taken from the lake by the dilution pumps; and discharges to the lake. The purpose of the dilution pumps and the discharge mixing basin is to reduce the discharge water temperature.

3.2 CHEMICAL TREATMENT SYSTEM MODIFICATIONS

The applicant's chemical treatment system for the closed-cycle mode of cooling has been presented in Section III.D.3.b, Proposed Cooling Tower System Chemical Treatment, of the FES. There have been two significant changes to the treatment scheme as previously reported, having to do with the use of phosphate-and-zinc-containing corrosion inhibitors in the recirculating cooling water system, and the chlorine usage and discharge at the plant.

The applicant has recently indicated that phosphate-and-zinc-containing corrosion inhibitors will not be used in the recirculating cooling water system, nor will any other corrosion inhibitor be used as such.[1] Sulfuric acid will still be used in the control of scaling in this system. Control of temperature in the system, control of total dissolved solids load carried in the system as well as the suspended solids load, and pH control will be the means used to control corrosion in the recirculating cooling water system.

The discharge of chlorine used as a biocide in the service and main recirculation cooling water systems has been altered from that presented in the FES. The applicant has adopted a procedure whereby the 1320 gpm cooling tower blowdown line is shut off during the chlorine injection periods for the recirculating cooling water system. Blowdown is suspended for such time as required for the total residual chlorine concentration to degenerate to a level of 0.05 mg/l or less.[2] This method takes advantage of the naturally occurring decay of residual chlorine in the presence of sunlight and air in the make-up basin. The recirculating cooling water system was first chlorinated on April 7, 1975. The applicant later learned that some of the chlorinated

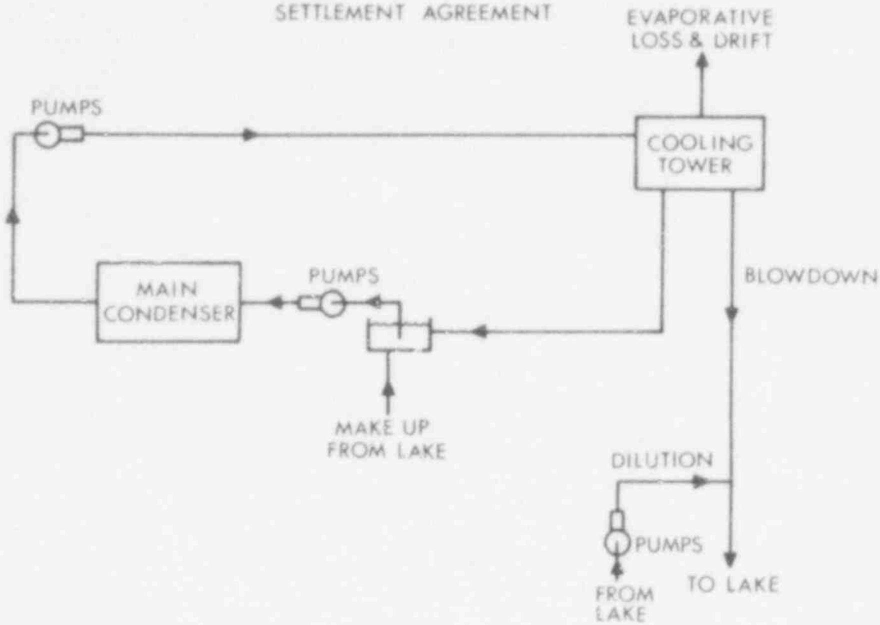


PALISADES NUCLEAR PLANT #988
General View
Looking Southeast
GWU 7098 20th May 1974
FIGURE 3-1

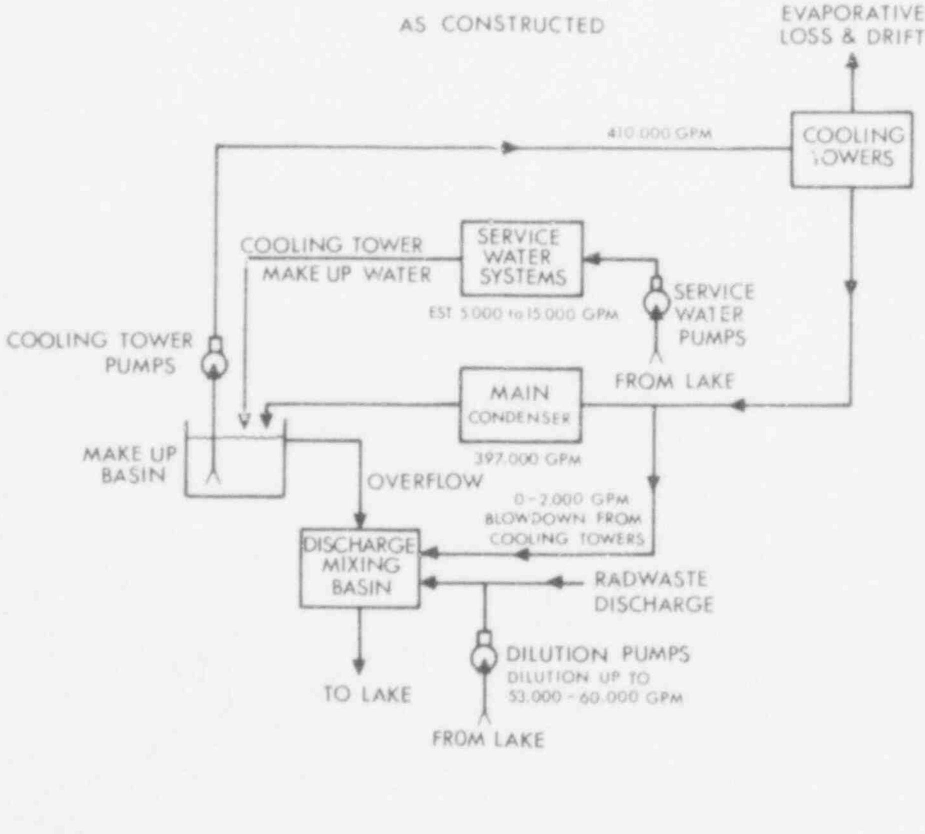
FIGURE 3-2

PALISADES PLANT
CLOSED CYCLE COOLING SYSTEM

CONCEPTUAL DESIGN
SETTLEMENT AGREEMENT



AS CONSTRUCTED



recirculating cooling water mixes with the discharged excess service water in the makeup basin and overflows into the discharge mixing basin and thence to Lake Michigan (see Figure 3-2). The flow rate and residual chlorine concentration of this discharged water are being monitored to determine compliance with the Environmental Technical Specifications.

Additionally, the applicant has changed the chemical treatment of the secondary coolant system from a phosphate treatment to an all volatile treatment scheme.[3] This type of treatment employs morpholine for pH adjustment and hydrazine for dissolved oxygen control in the secondary coolant system. Steam generator blowdown from this system is treated in the condensate polishing demineralizers and reused. The waste from this treatment is discharged with the demineralizer wastes or the radwaste. The release of either of these chemical species in the plant blowdown would result in virtually immeasurable concentrations in the discharge to Lake Michigan due to chemical degradation upon mixing with other plant waters and exposure to the atmosphere and through dilution with the blowdown itself.

There are no additional changes to the chemical treatment system as a result of the conversion to closed-cycle cooling.

3.3 RADIOACTIVE WASTE SYSTEM

3.3.1 Introduction

Since the Final Environmental Statement (FES) was issued, the applicant has installed the modified liquid and gaseous radwaste systems as proposed in the FSAR and as described in our FES dated June 1972. Based on more recent operation data applicable to Palisades, and on changes in our calculational model, we have calculated revised liquid and gaseous source terms for a reactor power level of 2638 MWt. The source terms given in Table III-7 and III-8 of the FES were based on a reactor power level of 2200 MWt and did not take credit for the proposed systems modifications. The revised source terms, shown in Table 3.2 and 3.3, were calculated using the models and parameters described in Regulatory Guide 1.BB, "Calculation of Releases of Radioactive Materials in Liquid and Gaseous Effluents from Pressurized Water Reactors (PWR's)," September 9, 1975, and credit for the system modifications was included.

The capability of the liquid and gaseous radwaste treatment system to meet the requirements of Appendix I to 10 CFR 50 will be evaluated and assessed in a supplement to the SER. In the interim, until such assessment is completed, the staff has prepared upper bound estimates of the potential effect on the estimated radiological environmental impact.

3.3.2 Liquid Radwaste System

The modified liquid radwaste system provides the capability to recycle all liquid radwastes for reuse in the plant, except for laundry wastes. In its evaluation, the staff assumed that 10% of the treated liquid radwastes will be discharged due to unanticipated operational occurrences and to control tritium inventory in the plant. The anticipated annual release of radioactive material in liquid effluents, given in Table III-8 of the FES, were based on all liquid radwaste that will be discharged to the environment. For the source term calculation, the staff assumed the average letdown rate to the chemical volume control system (CVCS) to be 40 gpm (system parameter from Final Safety Analysis Report) and the average shim bleed rate to the liquid radwaste system to be 1.4 gpm. The staff estimated the average waste flows from the equipment and floor drains to be 8.700 gpd and 900 gpd, respectively. The staff assumed the steam generator blowdown rate to be 5,000 gpd, which is consistent with actual operating data from Palisades. The principal parameters and conditions used for calculating releases of radioactive material in liquid effluents are given in Table 3.1.

3.3.3 Gaseous Radwaste System

The modified gaseous radwaste system increases the holdup capacity of the waste gas process system from 30 days to 60 days. The steam generator blowdown flash tank vent is routed to the main condenser hot well through the shell side of the feedwater heaters. The staff assumed four containment building purges per year, which is consistent with plant operating experience, while the source term in the FES assumed 12 purges per year. The anticipated annual releases of radioactive materials in gaseous effluent given in Table III-7 of the FES, were based on operation with 0.25 percent of the operating power fission product source term while the staff's revised source term given in Table 3.3 is based on 0.12 percent. The remainder of the principal parameters and conditions for calculating the source term for releases of radioactive material in gaseous effluent are given in Table 3.1.

TABLE 3.1

PRINCIPAL PARAMETERS AND CONDITIONS USED IN CALCULATING RELEASES OF RADIOACTIVE MATERIAL IN LIQUID AND GASEOUS EFFLUENTS FROM PALISADES NUCLEAR PLANT

Reactor Power Level (MWt)	2638
Plant Capacity Factor	0.80
Failed Fuel[a]	0.12%
Primary System	
Mass of Coolant (lbs)	4.04 x 10[illegible]
Letdown Rate to CVCS (gpm)	40
Shim Bleed Rate (gpm)	1.4
Leakage Rate to Secondary System (lbs/day)	100
Leakage Rate to Containment Building (lbs/day)	1%/day of primary coolant noble gas inventory 0.001%/day of primary coolant iodine
Leakage Rate to Auxiliary Building (lbs/day)	160
Frequency of Degassing for Cold Shutdowns (per year)	2
Secondary System	
Steam Flow Rate (lbs/hr)	1.2×10^7
Mass of Steam/Steam Generator (lbs)	9.4×10^3
Mass of Liquid/Steam Generator (lbs)	1.8×10^4
Secondary Coolant Mass (lbs)	3.5×10^5
Rate of Steam Leakage to Turbine Bldg. (lbs/hr)	1.7×10^3
Steam Generator Blowdown Rate (lbs/hr)	5.0×10^3
Dilution Flow (gpm)	6.0×10^5
Containment Building Volume (ft^3)	1.64×10^6
Frequency of Containment Purges (per year)	4
Iodine Partition Factors (gas/liquid)	
Leakage of Auxiliary Building	0.0075
Steam Leakage to Turbine Buidling	1
Steam Generator (carryover)	0.01
Main Condenser Air Ejector	0.15

Decontamination Factors (liquids)

	Boron Recycle	Equipment Drains	Waste Drains
I	1×10^6	1×10^6	1×10^4
Cs, Rb	2×10^3	4×10^4	2×10^4
Others	1×10^5	1×10^7	1×10^5

	All Nuclides Except Iodine	Iodine
Waste Evaporator DF	10^4	10^3
BPS Evaporator DF	10^3	10^2

	Anion	Cs, Rb	Other Nuclides
Mixed Bed Demineralizer			
Boron Recycle Feed (H_3BO_3)	10	2	10
Primary Coolant Letdown	10	2	10
Radwaste	10^2(10)	2(10)	10^2(10)
Evaporator Condensate Polishing	10	10	10
Anion Bed Demineralizer	10^2(10)	1(1)	1(1)

[a]This value is constant and corresponds to 0.12% of the operating power fission power source term.

TABLE 3.2

CALCULATED RELEASES OF RADIOACTIVE MATERIALS IN LIQUID EFFLUENTS FROM PALISADES NUCLEAR STATION

(Ci/yr)

Nuclide	Ci/yr
Corrosion and Activation Products	
Cr-51	1.1(-4)[a]
Mn-54	1.0(-3)
Fe-55	1.1(-4)
Fe-59	8.0(-5)
Co-58	5.0(-3)
Co-60	8,8(-3)
Np-239	5.0(-5)
Fission Products	
Br-83	3.0(-6)
Rb-86	1.0(-4)
Sr-89	2.0(-5)
Mo-99	3.6(-3)
Tc-99m	2.2(-3)
Te-127m	1.0(-5)
Te-127	1.0(-5)
Te-129m	8.0(-5)
Te-129	5.0(-5)
I-130	9.0(-5)
Te-131m	7.0(-5)
Te-131	1.0(-5)
I-131	2.4(-2)
Te-132	9.5(-4)
I-132	1.5(-3)
I-133	2.2(-2)
Cs-134	4.9(-2)
I-135	5.3(-3)
Cs-136	1.3(-2)
Cs-137	5.0(-2)
Ba-137m	2.5(-2)
Ba-140	1.0(-5)
All Others	6.0(-5)
TOTAL (except tritium)	2.4(-1)
Tritium Release	340

[a]Exponential Notation; 1.1(-4) = 1.1×10^{-4}

TABLE 3.3

CALCULATED RELEASES OF RADIOACTIVE MATERIALS IN GASEOUS EFFLUENTS FROM PALISADES NUCLEAR GENERATING PLANT

(Ci/yr)

Nuclides	Waste Gas Processing System	Building Ventilation Reactor	Building Ventilation Auxiliary	Turbine	Condenser Air Ejector	Total
Kr-83m	a	a	a	a	a	a
Kr-85m	a	a	2	a	2	4
Kr-85	270	45	2	a	1	320
Kr-87	a	a	1	a	a	1
Kr-88	a	a	4	a	3	7
Kr-89	a	a	2	a	a	a
Xe-131m	11	12	5	a	1	26
Xe-133m	a	5	1	a	3	13
Xe-133	82	940	360	a	220	1600
Xe-135m	a	a	a	a	a	a
Xe-135	a	1	8	a	5	14
Xe-137	a	a	a	a	a	a
Xe-138	a	a	a	a	a	a
I-131	a	3.2(-2)[b]	6.0(-2)	1.3(-3)	3.8(-2)	1.3(-1)
I-133	a	4.5(-3)	7.7(-2)	1.2(-3)	4.8(-2)	1.3(-1)
Co-60	-	-	-	-	-	
Co-58	-	-	-	-	-	
Fe-59	-	-	-	-	-	
Mn-54	-	-	-	-	-	
Cs-137	-	-	-	-	-	6.0(-2)
Cs-134	-	-	-	-	-	
Sr-90	-	-	-	-	-	
Sr-89	-	-	-	-	-	
C-14	-	-	-	-	-	8
H-3	-	-	-	-	-	710
Ar-41	-	-	-	-	-	25

a = less than 1.0 Ci/yr/noble gases, less than 10^{-4} Ci/yr for iodine.

b = 3.2×10^{-2}

3.3.4 Summary

Based on the evaluation of the modified liquid radwaste systems using the parameters in Table 3.1, the staff calculates the releases of radioactive materials in the liquid radwaste to be 0.24 Ci/yr excluding noble gases and tritium. Based on previous experience at operating reactors, the staff estimates the tritium releases to be 340 Ci/yr.

Based on parameters given in Table 3.1, the staff calculates the total radioactive gaseous releases from the modified gaseous radwaste system to be approximately 2,000 Ci/yr of noble gases, 0.13 Ci/yr of iodine-131, 8 Ci/yr of carbon-14, 710 Ci/yr of tritium, 25 Ci/yr of argon-41, and 0.06 Ci/yr of particulates.

The capability of the liquid and gaseous radwaste treatment systems to meet the requirements of Appendix I to 10 CFR Part 50 will be evaluated in the supplement to the SER. The staff does not expect the source terms to change significantly due to the detailed assessment in the supplement.

REFERENCES FOR SECTION 3

1. Request for Full-Term Operating License and Application for an Increase in Power Level: Palisades Unit No. 1, Amendment 28; Consumers Power Company, January 22, 1974.

2. Ninth Semiannual Report of Operations for the Palisades Nuclear Plant, January 1, 1975 to June 30, 1975; Consumers Power Company, August 31, 1975.

3. Amendment No. 28, Section 7, Appendix F to License DPR-20, Palisades Nuclear Plant; Consumers Power Company, July 9, 1975.

4. ENVIRONMENTAL IMPACT OF CONSTRUCTION OF PLANT MODIFICATIONS

RÉSUMÉ

The environmental impacts of site preparation and plant construction were as anticipated in Section IV of the FES. Observations on effects of cooling tower construction and controls to reduce or limit impacts are presented below.

4.1 ENVIRONMENTAL IMPACT OF COOLING TOWER CONSTRUCTION ACTIVITIES

Tower No. 2 was constructed in a blow-out area with sparse vegetation. The applicant removed shrubs, vines and herbs from the area. Surrounding dune slopes were stabilized by beach grass.

Tower No. 1 was located in an area of early successional stage forest. This vegetation type was removed during construction and a dune stabilization program was initiated using beach grass. The applicant selected sites for both towers in depressions, thus eliminating the need for extensive damage of coastal dunes. A laydown area used for construction of the two cooling towers was also planted with beach grass. The staff inspection of all areas of necessary dune stabilization measures found that beach grass was quite successful in stabilizing areas of potential erosion. The applicant indicated that a few small areas of beach grass had not initially taken hold and these areas were to be replanted with new beach grass until stabilization was assured.

The staff concurs with the applicant that beach grass is well adapted to dune stabilization and that other pioneer species will invade areas of transplanted beach grass once it becomes established and stabilizes the sand.

5. ENVIRONMENTAL IMPACTS OF PLANT OPERATION

RÉSUMÉ

The FES Section V discussion of effects of operation of Palisades, with a closed-cycle cooling system, on land use and water use is still valid; amplifying remarks are given in Sections 5.1 and 5.2 below. Biological impacts are still expected to be as stated in Section VC2; amplifying discussion is presented in Sections 5.3.1.1, 5.3.1.2, 5.3.2, and 5.3.3. A discussion of water quality in connection with issuance of a water quality certification and NPDES permit appears in Section 5.3.1.3. An expanded discussion of transmission effects and a discussion of social impacts are given in Sections 5.3.3.4 and 5.3.4. Overall, the FES Section V discussion of nonradiological impacts is correct for the increased power levels requested by the applicant. The FES Section V radiological analysis, however, was done for a steady-state core power level of 2200 MWt. Section 5.4 below discusses radiological impact for the higher power level requested. In addition, Section 5.5 discusses the environmental effects of the uranium fuel cycle.

The FES Section VI analysis (Environmental Impact of Postulated Accidents) is correct for the power levels requested (2638 MWt, 786 MWe).

5.1 IMPACT ON LAND-USE

Cooling towers and the surrounding areas will displace approximately 2 acres encompassing early successional forest and blow-out vegetation types. Operation of the plant's cooling towers do not affect any additional onsite land-use patterns. Biological impacts associated with the operation of cooling towers are discussed in Section 5.3.

5.2 IMPACT ON WATER USE

The Palisades Plant initially operated with a once-through condenser cooling system, utilizing Lake Michigan water for cooling. All future operations will use a closed-cycle mechanical draft cooling tower system which dissipates heat directly to the atmosphere.

The conversion to a closed-cycle cooling system significantly reduced both volume and temperature of the thermal discharge. Since the environmental effects of once-through cooling have not been significantly detrimental, it can be predicted that full-term operation at stretch rating with cooling towers, which still results in discharges substantially less than those which occurred during open-cycle operation, will have no significant negative impact on aquatic organisms. Entrainment and impingement aspects of closed-cycle operation are discussed in Section 5.3.1.2.

5.3 ENVIRONMENTAL IMPACT (NONRADIOLOGICAL)

5.3.1 Aquatic Impact

5.3.1.1 Impact of Chemical Effluents on Aquatic Biota

As stated in Section 3.2 of this addendum, the applicant has modified the chemical treatment system used at the plant so that the only chemicals being discharged from the recirculating cooling water system, aside from the concentrated levels of those chemical species already present in the lake water, are excess sulfates (from sulfuric acid treatment of the cooling towers) and residual chlorine. The method of corrosion control adopted by the applicant whereby chemical treatment is not used (other than sulfate addition) has effectively eliminated the impacts discussed in Section 5 of the FES due to zinc, chromate, or phosphate presence in the plant discharge.

The Federal Water Pollution Control Act Amendments of 1972, Section 302, require that limitations be placed on the operation of the facility which are necessary to protect and propagate a balanced indigenous aquatic population in the receiving waters and to protect other water users. In accordance with the Second Memorandum of Understanding and Policy Statement Regarding Implementation of Certain NRC and EPA Responsibilities, December 1975, the issuance by the State of Michigan of an NPDES permit under Section 402 of the FWPCA is accepted as a determination that the requirements mentioned above will be met.

The Initial Effluent Limitations imposed by the NPDES include a chlorine effluent limit above that recommended by Basch and Truchan (1974)[29], Brungs (1973)[30], and EPA[31]. These various recommendations are shown in Table 5.1[31]. In addition, these Initial Effluent Limitations do not contain any restriction on the time period of residual chlorine application or release. Based on this information, the staff believes that plant operation under these limitations has the potential to adversely impact the aquatic biota in the vicinity of the plant discharge through direct toxicity or exclusion of the area as suitable habitat. This adverse impact, should it occur, will be mitigated by the relatively short time that the plant will operate under these limits (i.e., until June 30, 1977).

The State of Michigan NPDES (National Pollutant Discharge Elimination System) Permit for the Palisades Plant limits the total residual chlorine in all plant cooling tower discharges to 0.5 mg/l under the Initial Effluent Limitations, effective June 30, 1977; and after July 1, 1977, the NPDES Permit Final Effluent Limitations restrict total residual chlorine discharges as follows: "When discharge water temperatures are $\leq 70^{o}F$, total residual chlorine concentrations shall not exceed 0.004 mg/l. When discharge water temperatures are $> 70^{o}F$, total residual chlorine concentrations shall not exceed 0.20 mg/l. Total time of application shall be limited to not more than 4 hours in any 24-hour period." In the FES (pp. V-48 through V-52), the impact of 0.5 ppm chlorine residual on fish in a once-through Palisades cooling system was evaluated, and it was concluded that in summer "the impact could be significant, either through mortality or (more likely) exclusion of the area as suitable habitat...It is concluded that limitation of the residual chlorine concentration of 0.5 ppm at the point of discharge into Lake Michigan and restriction of the length of the chlorination treatment to one hour per month should reduce, but not eliminate, the adverse effect on aquatic biota near the Palisades Plant site." The FES also evaluated the discharge of residual chlorine from the closed cycle cooling system at a level of 0.22 ppm resulting from system chlorination for 1 hour per day. It was concluded that the reduced initial concentration and the smaller volume of effluent (i.e., blowdown) would result in less impact than the once through system, even though the frequency of release would be increased.

The Final Effluent Limitations provide for residual chlorine release magnitude within the limitations recommended by Basch and Truchan[29] and Brungs[30]. However, the application time allowed could result in residual chlorine discharges for periods of time greater than the 2 hours/day recommended by Brungs and EPA researchers[31] and the EPA Steam Electric Generating Point Source Category Effluent Guidelines. Adverse impacts could result from these extended periods of discharge.

It should be noted that the latest monitoring report[1] has revealed an instance of possible detrimental effects of plant operation on the aquatic biota. This occurred during the period between April 7, 1975 and June 30, 1975 when it was discovered that water exchange takes place in the make-up basin between the chlorinated cooling tower blowdown and the excess service water, which is normally discharged to the mixing basin and then to Lake Michigan. This sequence of events allows chlorinated blowdown water to reach Lake Michigan where on four occasions between May 24, 1975 and June 18, 1975 fish mortalities have been noted. These mortalities have been reported by the applicant as occurring prior to the beginning of a chlorination cycle. One of the incidents was reported as persisting beyond the chlorination cycle, although none of the mortalities has been attributed to chlorine by the applicant. Because this path for the chlorinated blowdown was not monitored prior to May 24, 1975, and the total residual chlorine concentration in the discharge (i.e., blowdown) is not known with certainty, additional mortalities to fish and other aquatic biota could have occurred since chlorination was initiated on April 7, 1975. The applicant is conducting a program to determine the chlorine residual in the escaping blowdown, the amount of impact to the receiving water biota and to determine what additional changes are necessary in plant systems to eliminate or reduce to acceptable levels, any impact from this source. Initial measurements[1a] indicate that the total residual chlorine in this discharge has an average of 0.01 ppm with a maximum of approximately 0.06 ppm. These levels of chlorine discharge are not likely to produce fish mortalities because of the limited duration and area of exposure.

The State of Michigan NPDES permit limits the pH of the discharges from the plant to the range of 6.5 - 9.5. Since August 30, 1974, the Palisades Technical Specifications have limited the pH of discharges to the range of 6.5 - 8.8. The FES found the closed cycle cooling system discharge pH of 6.5 - 9.5 to be acceptable. Operation of the plant within this pH range is not expected to produce any adverse effects.

The analysis presented in Section 5 of the FES is still considered valid by the staff with respect to the long term buildup of dissolved salts in Lake Michigan in the vicinity of the plant.

TABLE 5.1

CHLORINE TOXICITY - FRESH WATERS

Author and year	Type of exposure	Concentration of total residual chlorine	Degree of protection and remarks
Blue Book, 1972	Continuous	0.003 mg/l	Most sensitive species.
	Intermittent	0.05 mg/l	Up to 30 minutes in any 24-hour period.
Duluth staff, 1972	Continuous	0.1 mg/l	Warmwater species - won't protect some sensitive invertebrates.
	Continuous	0.002 mg/l	Protects most species, including trout.
	Intermittent	0.1 mg/l	30 minutes per day - protects most species.
	Intermittent	0.005 mg/l	Not to exceed 2 hours per day - protects most species.
Brungs, 1973	Continuous	0.01 mg/l	Warmwater species - won't protect sensitive life stages and some invertebrates.
	Continuous	0.002 mg/l	Protects most species.
	Intermittent	0.2	Not to exceed 2 hours per day - protects warm water species.
	Intermittent	0.04 mg/l	Not to exceed 2 hours per day - protects most species, including salmonids.
Mich. WRC, 1974	Continuous	0.02 mg/l	Warmwater species.
	Continuous	0.005 mg/l	Coldwater species.
	Intermittent	0.2 mg/l	Warmwater species - not to exceed 30-minute exposures.
	Intermittent	0.04 mg/l	Coldwater species - not to exceed 30-minute exposures.
Guidelines, 1974	Intermittent	0.5 mg/l max. 0.2 mg/l avg.	Cannot discharge from any one unit more than 2 hours per day. The concentrations in guidelines are for free available chlorine.

Source: Ref. 3/

5.3.1.2 Entrainment and Impingement Effects

Conversion of the cooling system from open to closed mode will substantially reduce the volume of water taken into the plant and hence the total numbers of entrained plankton. It is conservatively assumed that 100% of the plankton entrained in the cooling tower make-up flow will be killed. Little mortality is expected in the dilution water added to the blowdown in the discharge basin because of its high capacity-low head operating conditions. Assuming 10% mortality with the once-through system and 2% mortality in the dilution water, the total numbers of zooplankton that would be killed by closed-cycle operation will be about one-third those killed by open-cycle operation.

Studies to determine entrainment mortality estimates on fish eggs and larvae have not been conducted at Palisades. It is believed that mortality would be somewhat greater than that for zooplankton, but it is not possible to estimate these losses. Using the mortality estimates and the same assumptions used for zooplankton would result in about a two-thirds reduction in the total number of fish eggs and larvae killed. As no significant reductions in fish populations were found by the monitoring programs during open operation, no demonstratable impact due to entrainment of fish eggs and larvae is expected as a result of closed-cycle cooling.

Impingement of fish can be conservatively assumed to be reduced in proportion to the reduction of total intake flow which is a factor of about 5.5. Using the predicted value and actual values discussed in Section 2.2.1 this could result in between 5,000 to 10,000 lbs of fish per year. The actual reduction should be even more significant than indicated by just the flow reduction because of the effect of reducing the intake approach velocity.

5.3.1.3 Water Quality Effects

State of Michigan Water Quality Certification:

The Palisades Nuclear Generating Plant has received a water quality certification from the State of Michigan Department of Natural Resources. This certification fulfills the requirements for water quality certification as provided in Section 401 of the Federal Water Pollution Control Act Amendments of 1972.

State of Michigan Water Quality Standards and USEPA Effluent Guidelines:

The water quality certification for the Palisades Nuclear Generating Plant has been conditioned by the State of Michigan through the issuance of a USEPA approved NPDES permit issued on August 2, 1976, under Section 402 of the FWPCA. This action by the State of Michigan indicates compliance with the applicable water quality requirements. In this case, said requirements are the State of Michigan Department of Natural Resources General Rules, Part 4, Water Quality Standards, December 12, 1973. These requirements have been approved by the U.S. Environmental Protection Agency. Inasmuch as these standards, under Rule 323.1080 Special Conditions, consider the agreement between the United States and Canada on Great Lakes water quality, effective on April 15, 1972, the issuance of the NPDES permit further indicates compliance with this international agreement.

5.3.2 Meteorlogical Effects of Cooling Towers

Expected meteorological effects of the mechanical-draft cooling towers were discussed in the FES (Section V). Operational experience has thus far been insufficient to assess actual impact of the towers on frequency of fogging, icing, and precipitation, hence there is no basis for changing conclusions reached therein.

5.3.3 Terrestrial Impacts

5.3.3.1 Operational Acoustic Environment

The applicant conducted three separate operational sound pressure level surveys in and around the Palisades site during 1975 to yield data to compare with the ambient sound pressure level survey reported in Section 2.2.4.[3] These surveys, dated May 7, 1975, June 10, 1975 and July 16, 1975 sampled daytime and nighttime periods when plant load was at least 80% of full power rating and 34 of 36 cooling tower cells were in operation. Refer to Figure 2.4.4-1 for the sampling locations. The range of sound pressure levels recorded during the operational surveys is given in Table 5.1.

TABLE 5.1[3]

OPERATIONAL SOUND LEVEL SURVEYS

Survey Date	Time Period	Sound Level, dBA re 2×10^{-5} N/m^2 Min. (Location)	Max. (Location)
May 7, 1975	Day	40 (pts. 12 and 17)	57 (pt. 7)
June 10, 1975	Day	40 (pt. 17)	59 (pt. 9)
July 16, 1975	Day	43 (pts. 1 and 17)	66 (pt. 13)
May 7, 1975	Night	40 (pt. 15)	59 (pt. 9)
June 10, 1975	Night	40 (pts. 15 and 17)	61 (pt. 9)
July 16, 1975	Night	No Measurements Taken	

The daytime and nighttime sound pressure levels recorded for the site boundary locations 1, 6, 11 and 17 and the offsite locations 12 and 15 are shown in Table 5.2. The staff has compared the average daytime and nighttime sound pressure levels at these sampling locations in the three octave bands important to speech communication. The Speech Interference Level[4] was computed using the preferred octave bands of ANSI Standard S1.6-1967[5] and at every location (pts. 1, 6, 11, 12, 15 and 17) the necessary voice effort for communication would not be above that considered as normal for virtually all expected voice communication distances.

The three independent samples for each location do not exhibit unusual variability, a factor which would support a hypothesis that the values are between the background noise level (i.e., the L_{90}) and the intrusion noise level (i.e., the L_{10}). After examination of the levels reported for each location and time period in Table 5.2, the staff believes that the operation of the plant with the mechanical draft cooling towers does not present an unacceptable impact on the acoustic environment in the site vicinity. However, the average levels are based upon three independent instantaneous samples from each category. As was indicated in Section 2.4.1, the staff cannot make any further analyses or assume any quantitative characterization of these sound levels with respect to distributive statistics.

5.3.3.2 Drift Impacts

The applicant estimates that the drift is expected to be deposited at relatively short distances from the towers, all within 800 feet and 70% within 100-300 feet (ER-Appendix E). The basis for this estimation is that the average height of mechanical draft towers of 50 feet would deposit drift within relatively short distances from the tower. The staff is in agreement with this assessment primarily due to the fact that the Palisades Nuclear Generating Plant's mechanical draft towers are enclosed by high dunes on three sides with only the side facing Lake Michigan remaining open.

TABLE 5.2[3]

OPERATIONAL SOUND LEVELS AT BOUNDARY

AND OFFSITE LOCATIONS

Sampling Location Identification No.	Sound Level, dBA re 2×10^{-5} N/m^2 Daytime Range	Daytime Average	Nighttime Range	Nighttime Average
1 (boundary)	43-52	46	42-45	43.5
6 (boundary)	44-46	45	43-44	43.5
11 (boundary)	47-48	47.5	47-51	49
12 (offsite)	40-45	42.5	41-44	42.5
15 (offsite)	35-47	43	40	40
17 (boundary)	40-43	41	40-46	43

5.3.3.3 Moisture Effects on Orchards

The site is located in an area where most agricultural operations are centered around horticultural crop production of blueberries, cherries, apples, pears, plums, nectarines and peaches. Plant diseases often lower both yield and quality of many Michigan-grown horticultural crops.[7]

Climate exercises a strong control on the incidence and distribution of plant diseases. Temperature, relative humidity, and wind are the three principal components of the plant's atmosphere and soil environment most critical to disease development. Humidity and precipitation in the form of rain, fog, and dew determine not only the seasonal incidence of disease but also limit their geographic distribution.

Weather thus greatly influences disease incidence. Apple scab, for example, can be controlled through properly timed application of fungicides. However, for a spray program to be effective, as well as economical enough to justify its results, weather conditions and forecasts must be given careful consideration. Temperature and duration of wetting are closely linked in their influences on most fruit tree diseases. Actual programs must be constantly adjusted according to prevailing environmental conditions to achieve the best results. Cooling tower moisture may contribute to background levels of humidity, thus creating a need for increased applications of disease control sprays. The staff believes accurate determinations of unacceptable increases in local humidity regimes requiring increases in orchard spray applications due to operation of cooling towers cannot be made at this stage. The applicant, in cooperation with an orchard grower, has installed offsite meteorological equipment at an orchard site about 3 miles ESE of the towers. The staff concurs with the applicant's assessment that a monitoring program using leaf-wetness recorders or other similar instrumentation would not provide meaningful data.

The staff concludes that the applicant's present monitoring program will be able to provide adequate data to determine any large changes in disease incidence patterns due to cooling towers.

However, the staff is aware that the present monitors are only sensitive enough to detect changes greater than 10%. It is the staff's judgment that local offsite moisture regimes changes due to the operation of the Palisades Plant mechanical-draft cooling towers will be small and thus may be obscured by normal background variations. However, the staff does recommend that the applicant be required to conduct a survey in cooperation with area growers to determine what effects, if any, are associated with cooling tower operation (Section 6.3).

5.3.3.4 Transmission Rights-of-Way

The Palisades-Argenta right-of-way (ROW) corridor extends 40.5 miles crossing two counties. The average width of this ROW is 350 feet and it is comprised of 218 tracts of which 179 are in fee (39 tracts are for vegetation control). Total fee acreage accounts for 1753.15 acres. 1062.25 acres are leased for farming for a term of 10 years plus one renewal option of 5 years. The "Palisades Exit" transmission corridors immediately east of the plant and running approximately 4 miles in Covert Township occupies 47 tracts totalling 515.75 acres. This right-of-way is incompatible for farming according to the applicant.[8]

Maintenance

The applicant currently uses herbicides at six-year intervals for row maintenance. The applicant states that proper precautions will be taken to protect low growing species, farm crops, wildlife, erosion areas and scenic areas from herbicide treatment in accordance with Federal Power Commission Order 414, Appendix A, Item 4F ("Response to Staff Questions," Amendment No. 28, Section F, Appendix F"). Vegetation screens are maintained to reduce the tunnel view visual impact.

The staff concludes that the maintenance procedures committed-to by the applicant are acceptable to insure that adverse environmentla effects will be at the minimum practicable level, with the following additional precautions:

(1) Aerial application of herbicides will be restricted from those areas adjoining homes, yards, gardens, croplands, lakes, streams, parks, preserves, screening vegetation for road and stream crossings, and congested, intensely-used or urban corridors.

(2) Aerial application of herbicides will not be carried out in winds greater than 5 mph.

(3) Herbicides will be applied only by a licensed applicator or under his direct supervision.

Effects of Chemical Herbicide

The herbicides currently being used by the applicant in his maintenance program are as follows:

2,4,5-T

Banvel 4-WS

The normal sequence of herbicide treatment will be at six-year intervals. All the herbicides listed have generally short residence times in the environment. It is expected that residuals would not be detectable in soils, plants, animals, or waters after periods of several months from the time of spraying.

The staff believes that EPA registration of these herbicides, application of these herbicides consistent with the recommended conditions of use described on product labels (togegher with the additional precautions prescribed by the staff above), and adequate reporting procedures in the Technical Specifications will insure safe use of these herbicides.

Effects of Ozone

The Natural Primary Air Quality Standard for oxidants, as issued by the Environmental Protection Agency, is 80 parts per billion (ppb) by volume maximum arithmetic mean for a one-hour concentration, not to be exceeded more than once per year (App. D. of 42 CFR 410).

However, ozone may be injurious to vegetation and animals at even lower concentrations and where exposure is over prolonged periods.[9-12] Duration of exposure, age, temperature, relative humidity, vigor, presence of other pollutants, and light intensity, among others, all affect the response of a particular species to ozone,[13] thereby making it extremely difficult to assess the possible effects of a particular concentration of ozone on natural and domesticated biota or human beings.

Ozone and small amounts of nitrogen oxides are produced by corona discharge from energized high voltage transmission lines. Maximum ozone concentrations in the immediate vicinity of transmission lines at voltage up to 765-kV have been calculated[14] and the highest concentration (1.9 to 19.3 ppb) thus occurs in the rare case in which a very light wind blows exactly parallel to a long stretch of transmission line during foul weather.

Several field studies[15,16] have indicated that no increase in ambient levels were found under a variety of weather conditions near energized 765-kV lines.

Based upon the cited references and the fact that Palisades-Argenta transmission system will be of lower voltages (345-kV), the staff believes that the transmission line may be operated in an environmentally acceptable manner in reference to ozone generation. Contributions from this line are expected to constitute a minor part of ambient ozone levels and will be well below the Natural Primary Air Quality Standard described above.

Effects of Induced Currents

The electric field associated with an energized 345-kV transmission line may induce voltages in conducting objects within the field. If the object is well grounded, the resulting potential between the object and the ground will be near zero. However, if the object is insulated from the ground, significant voltages may be induced and a potential shock hazard created.[17,18] The magnitude of the charge and therefore the severity of the shock will be related to parameters associated with the transmission line design, line voltage, size and dimensions of the object, proximity of the object to the line, and degree of insulation of the object from the ground.

The quality of the insulation between a person coming in contact with such an object and the earth will also affect the severity of the shock. Body passage currents caused by contact with a charge object may range from barely detectable to those resulting in lethal effects. The staff recommends that care should be taken to ensure that all potentially affected stationary structures and objects directly beneath the 345-kV line, such as homes and barns with metal roofs and metal fences, are adequately grounded to prevent the building up of induced voltages. The applicant is committed to responding to all problems associated with electrostatic induction effects and correcting such problems by undertaking adequate grounding procedures. (Applicant response to staff questions, April 25, 1975, item IV.B.2).

The staff concludes from the above analysis and resulting staff requirements that electrostatically induced currents along the applicant's 345-kV line will most likely not cause any inconvenience to residents who live near the corridor and there is little likelihood of mortality caused by electrocution of persons or animals from this 345-kV line.

5.3.4 Social Impacts

This section first discusses social impacts of the present plant, operating at up to 686 MWe. Then the social impacts of the proposed 100 MWe uprating are discussed.

The operation of the plant produces considerable tax revenues for the region. Table 5.3 shows the applicant's tax payments to Covert Township.

The plant employs 135 people, 90% of whom relocated their residences to be within commuting distance of the plant. The annual payroll is approximately $2,260,000.[21]

The annual value of local purchases for use in association with the plant is estimated at $400,000. This figure includes costs for air conditioner service, temporary manpower, sanitation service, telephone service, fuel, and hardware and lumber.[21]

The possibility of moisture effects, from the Palisades mechanical draft cooling towers, on local orchards and the desirability of continued monitoring are discussed in Section 5.3.3.3. No estimate of the financial impact of increased incidence of diseases on the local agricultural economy can be made at this time in the absence of the likely incidence pattern of orchard diseases.

TABLE 5.3

ACTUAL AND FORECAST TAX PAYMENTS ON THE PALISADES PLANT BY CONSUMERS POWER COMPANY TO COVERT TOWNSHIP - 1972 THROUGH 1980

Year	Original Cost Less Deductions ($1000)	Utilization Factor (Percent)	Taxable Cost ($1000)	Equalization Factor (Percent)	Equalized Valuation ($1000)	Millage Rate	Tax Based On Millage ($1000)	1% Collection Fee ($1000)	Total Tax ($1000)
ACTUAL TAXES PAID									
1972	(a)	(a)	(a)	(a)	31,309	40.87	1,280	12	1,292
1973	(a)	(a)	(a)	(a)	40,808	32.38	1,321	13	1,335
1974	(a)	(a)	(a)	(a)	27,073	49.84	1,349	13	1,363
FORECAST TAX PAYMENTS									
1975	129,604	35	44,864	50	22,431	49.84	1,118	11	1,129
1976	129,604	52	67,394	50	33,697	50.34	1,696	17	1,713
1977	129,604	60	77,763	50	38,881	50.84	1,977	20	1,996
1978	129,604	70	90,723	50	45,362	51.35	2,329	23	2,353
1979	129,604	75	97,203	50	48,602	51.86	2,520	25	2,546
1980	129,604	80	103,683	50	51,842	52.38	2,715	27	2,743

SOURCE: Consumers Power Company, Environmental Report, Request for Full-Term Operating License and Application for an Increase in Power Level, Palisades Unit No. 1, Amendment 28, U.S. Nuclear Regulatory Commission, Docket No. 50-255, January 22, 1974, supplement dated April 25, 1975, Appendix F.

[a] Information not furnished by applicant.

The staff has identified and assessed potential impacts of a 100 MWe uprating of the Palisades Nuclear Plant on the residents, municipalities and economy of the local region. The most noteworthy impact will be increased tax payments, to Covert Township, due to an anticipated increased utilization factor for the Plant. Table 5.3 shows the applicant's actual and estimated tax payments to Covert Township for the years 1972 through 1980. To the extent that the increasing utilization factor reflected through 1980 is supported by the proposed 100 MWe uprating, this uprating will add to the tax revenues of Covert Township. While additional tax benefits will accrue to Covert Township, the uprating will impose no additional demands on that or any other community's facilities and services, because no additional plant personnel are required nor is the level of purchases within the local region perceivably altered.[21] The staff concludes, from information currently available, that any stresses on the local region, resulting from a 100 MWe uprate of Palisades, will be minor, if in fact they occur at all.

5.4 RADIOLOGICAL IMPACT

5.4.1 Impact on Biota Other Than Man

5.4.1.1 Exposure Pathways

The pathways by which biota other than man may receive radiation doses in the vicinity of a nuclear power station are shown in Figure 5-1. Two comprehensive reports[22,23] have been concerned with radioactivity in the environment and these pathways. They can be read for a more detailed explanation of the subjects that will be discussed below. Depending on the pathway being considered, terrestrial and aquatic organisms will receive either approximately the same radiation doses as man or somewhat greater doses. Although no guidelines have been established for desirable limits for radiation exposure to species other than man, it is generally agreed that the limits established for humans are also conservative for these species.[24]

5.4.1.2 Radioactivity in the Environment

The quantities and species of radionuclides expected to be discharged annually by the Palisades Plant in liquid and gaseous effluents have been estimated by the staff and are given in Tables 3.2 and 3.3, respectively. The basis for these values is discussed in Section 3.3. For the determination of doses to biota other than man, specific calculations are done primarily for the liquid effluents. The liquid effluent quantities, when diluted in the Palisades Plant discharge, would produce an average gross activity concentration, excluding tritium, of 0.0020 pCi/ml in the plant discharge area. Under the same conditions, the tritium concentration would be 2.9 pCi/ml.

Doses to terrestrial animals such as rabbits or deer due to the gaseous effluents are quite similar to those calculated for man (Section 5.4.2).

5.4.1.3 Dose Rate Estimates

The annual radiation doses to both aquatic and terrestrial biota were estimated on the assumption of constant concentrations of radionuclides at a given point in both the water and air. Referring to Figure 5-1, radiation dose has both internal and external components. External components originate from immersion in radioactive air and water and from exposure to radioactive sources on surfaces, in distant volumes of air and water, in equipment, etc. Internal exposures are a result of ingesting and breathing radioactivity.

Doses will be delivered to aquatic organisms living in the water containing radionuclides discharged from the power station. This is principally a consequence of physiological mechanisms that concentrate a number of elements that can be present in the aqueous environment. The extent to which elements are concentrated in fish and aquatic plants upon uptake or ingestion has been estimated. Values of relative biological accumulation factors (ratio of concentration of nuclide in organisms to that in the aqueous environment) of a number of waterborne elements for several organisms are provided in Table 5.4.

Doses to aquatic plants and fish living in the immediate area of the discharge due to water uptake and ingestion (internal exposure) were calculated to be 0.32 and 2.0 millirads per year, respectively, for Palisades Plant operation. The discharge region concentrations were those given above and it was assumed that these organisms spent all of the year in water of maximum concentrations. All calculated doses are based on standard models.[23] The doses are quite conservative since it is highly unlikely that any of the mobile life forms will spend a significant portion of their life spans in the maximum activity concentration of the discharge region. Both radioactive decay and additional dilution would reduce the dose at other points.

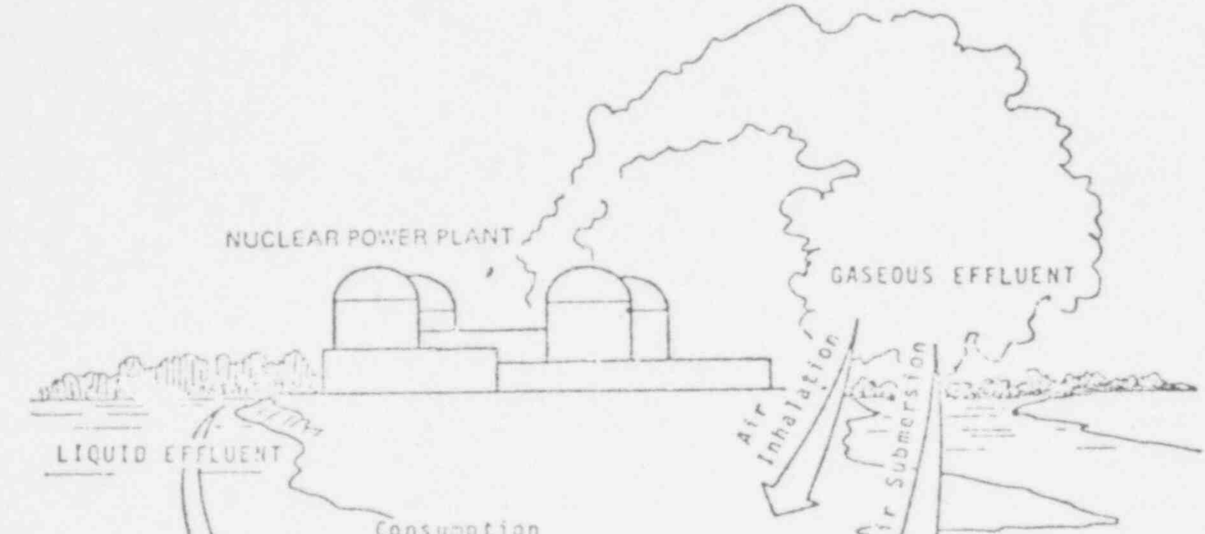


Fig. 5-1 Exposure Pathways to Biota Other than Man.

POOR ORIGINAL

710347

TABLE 5.4

FRESHWATER BIOACCUMULATION FACTORS

Element	Fish	Invertebrates (pCi/kg organism per pCi/liter water)	Plants
C	4,550	9,100	4,550
Na	100	200	500
P	100,000	20,000	500,000
Sc	2	1,000	10,000
Cr	200	2,000	4,000
Mn	400	90,000	10,000
Fe	100	3,200	1,000
Co	50	200	200
Ni	100	100	50
Zn	2,000	10,000	20,000
Rb	2,000	1,000	1,000
Sr	30	100	500
Y	25	1,000	5,000
Zr	3	7	1,000
Nb	30,000	100	800
Mo	10	10	1,000
Tc	15	5	40
Ru	10	300	2,000
Rh	10	300	200
Ag	2	770	200
Sn	3,000	1,000	100
Sb	1	10	1,500
Te	400	150	100
I	15	5	40
Cs	2,000	100	500
Ba	4	200	500
La	25	1,000	5,000
Ce	1	1,000	4,000
Pr	25	1,000	5,000
Nd	25	1,000	5,000
Pm	25	1,000	5,000
Sm	25	1,000	5,000
Cu	25	1,000	5,000
Gd	25	1,000	5,000
W	1,200	10	1,200
Np	10	400	300
Pu	4	100	350
Am	25	1,000	5,000
Cm	25	1,000	5,000

From Report UCRL-50564, Rev. 1.

External doses to terrestrial animals other than man are determined on the basis of gaseous effluent concentrations and direct radiation contributions at the locations where such animals may actually be present. Terrestrial animals in the environs of the station will receive approximately the same external radiation doses as those calculated for man.

An estimate can be made for the ingestion dose to a terrestrial animal such as a duck, which is assumed to consume only aquatic vegetation growing in the water in the discharge region. The duck ingestion dose was calculated to be about 5.5 millirads per year, which represents an upper-limit estimate, since equilibrium was assumed to exist between the aquatic organisms and all radionuclides in water. A nonequilibrium condition for a radionuclide in an actual exposure situation would result in a smaller bioaccumulation and therefore in a smaller dose from internal exposure.

The literature relating to radiation effects on organisms is extensive, but few studies have been conducted on the effects of continuous low-level exposure to radiation from ingested radionuclides on natural aquatic or terrestrial populations. The most recent and pertinent studies point out that, while the existence of extremely radiosensitive biota is possible and while increased radiosensitivity in organisms may result from environmental interactions, no biota have yet been discovered that show a sensitivity to radiation exposures as low as those anticipated in the area surrounding the Palisades Plant. In the "BEIR" report,[25] it is stated in summary that evidence to date indicates that no other living organisms are very much more radiosensitive than man. Therefore, no detectable radiological impact is expected in the aquatic biota or terrestrial mammals as a result of the quantity of radionuclides to be released into the Lake Michigan and into the air by the Palisades Plant.

5.4.2 Radiological Impact on Man

The revised Appendix I assessment of individual doses has not been completed. For the interim, it can be said that the individual doses associated with the radioactive releases of the Palisades Plant will be in accord with the requirements stated in Appendix I.

The staff has developed a procedure to quantitatively evaluate the maximum integrated doses which could be delivered to the U.S. population by radioactive emissions from the Palisades Plant. A description of this procedure for gaseous effluents is contained in attached Appendix B. The intent of this estimate is to evaluate the radiological environmental impact of the facility by establishing an upper bound population dose associated with plant operation.

5.4.2.1 Liquid Effluents

Expected radionuclide releases in the liquid effluent have been estimated for Palisades Plant and are listed in Table 3.2. Doses to the population from these releases were calculated using dose procedures consistent with the recommendations of ICRP-II.[29]

The cumulative dose resulting from the consumption of fish harvested from Lake Michigan was estimated. It was conservatively assumed that 100% of the population within 50 miles of the plant consumed 5 g of fish per day caught in the region of the lake where the coolant water discharges were diluted by an additional factor of 10 over those dilutions in the discharge canal.

The exposed recreational population was estimated to represent 10% of the total population within a 50-mile radius, and each person was assumed to be exposed during 1 hr per year each of swimming and boating and 4 hr per year of shoreline activities in the plant vicinity.

The tritium released to the receiving water is assumed to enter the biosphere in the same manner as tritium released to the atmosphere. The tritium discussion in Appendix B applies to all tritium sources from the plant.

Table 5.5 includes the doses to the population due to the release of radionuclides in the liquid effluents.

TABLE 5.5

ANNUAL INTEGRATED DOSE TO U.S. POPULATION

Radionuclide Group	Annual Dose (man-rem)	
	Total Body	Thyroid
Noble Gases	.63	.63
Radioiodine	.086	35.
Particulate	1.9	1.5
Tritium	.54	.54
Carbon-14	25.	25.
TOTAL	28.	63.

5.4.2.2 Gaseous Effluents

NRC staff estimates of the probable gaseous releases listed in Table 3.3 were used to evaluate potential doses to the U.S. population. As discussed in Appendix B these effluents were considered in five categories; viz. noble gases, radioiodines, particulates, carbon-14, and tritium. Krypton-85 was treated separately from the other noble gases because of its relatively long half-life (about 11 years).

The population can be exposed via the pathways discussed in Appendix B. External total body irradiation results from submersion in dispersed noble gases and from standing on surfaces containing deposited radioiodines and particulates. Internal total body and organ exposures result from inhalation of contaminated air or ingestion of contaminated foodstuffs. Three food pathways were evaluated which involved consumption: meat, milk, and food crops.

Doses to the population were calculated by assuming uniform dispersal of the radionuclides. Direct exposure pathways to the population (e.g., noble gas submersion) were based upon a uniform population density (160 people/mi^2). Indirect food pathways were based upon the assumption that meat, milk, and crop productivity of the land area east of the Mississippi River is capable of supporting the U.S. population.

Table 5.6 lists the population doses resulting from this analysis.

5.4.2.3 Evaluation of Radiological Impact

Using conservative assumptions, the staff has estimated an upper bound integrated exposure to the general population of the U.S. due to operation of the Palisades Plant to be 94 man-rem. Appendix I to 10 CFR 50 requires that individual doses be kept to a small fraction of the doses implied by 10 CFR 20.

This exposure can be placed in perspective by noting that individuals in the U.S. population each receive an average of about 100 mrem/year from natural background radiation. Thus, the annual population dose due to natural background to the U.S. population is about 21,000,000 man-rem.

Both the maximum individual doses and the upper bound population doses resulting from operation of the Palisades Plant are fractions of the doses individuals and the population receive from naturally occurring radiation.

TABLE 5.6

SUMMARY OF ANNUAL DOSES TO THE U.S. POPULATION

Category	Population dose (manrem/year)
Natural environmental radioactivity	21,000,000
Nuclear plant operation	
Plant work force	450
General public	
Gaseous and liquid effluents (total body and thyroid)	91
Transportation of nuclear fuel and radioactive wastes	3

5.4.2.5 Direct Radiation

5.4.2.5.1 Radiation from the Facility

The plant design includes specific shielding of the reactor, holdup tanks, filters, demineralizers, and other areas where radioactive materials may flow or be stored, primarily for the protection of plant personnel. Direct radiation from these sources is therefore not expected to be significant at the site boundary. Low level radioactivity storage containers outside the plant are estimated to contribute less than 0.01 millirems per year at the site boundary. The observed gamma radiation levels (at the site boundary) for 1973, 1974, and the first 6 months of 1975 were statistically indistinguishable from background.

5.4.2.5.2 Transportation of Radioactive Material

The transportation of cold fuel to a reactor, of irradiated fuel from the reactor to a fuel reprocessing plant, and of solid radioactive wastes from the reactor to burial grounds is within the scope of the NRC report entitled, "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants." (WASH-1238, December 1972) The environmental effects of such transportation are summarized in Table 5.7.

5.4.2.5.3 Occupational Radiation Exposure

Based on a review of the applicant's Preliminary Safety Analysis Report, the staff has determined that individual occupational doses can be maintained within the limits of 10 CFR 20. Radiation dose limits of 10 CFR 20 are based on a thorough consideration of the biological risk of exposure to ionizing radiation. Maintaining radiation doses of plant personnel within these limits ensures that the risk associated with radiation exposure is no greater than those risks normally accepted by workers in other present-day industries.[27] Using information compiled by the Commission[28] on past experience from operating nuclear reactor plants (with a range of exposures of 44-5134 man-rem per year) it is estimated that the average collective dose to all onsite personnel at large operating nuclear plants will be approximately 450 man-rems per year per unit. The total dose for this plant will be influenced by several factors for which definitive numerical values are not available. These factors are expected to lead to doses to onsite personnel lower than those estimated here. Improvements to the radioactive waste effluent treatment system to maintain offsite population doses as low as practicable may cause an increase in onsite personnel doses if all other factors remain unchanged. However, the applicant's implementation of Regulatory Guide 8.8 and other guidance provided through the staff radiation protection review process is expected to result in an overall reduction of total doses from those currently experienced. Because of the uncertainty in the factors modifying the above estimates, a value of 450 man-rems will be used for the occupational radiation exposure for the one-unit station.

TABLE 5.7

ENVIRONMENTAL IMPACTS OF TRANSPORTATION OF FUEL AND WASTE TO AND FROM ONE LIGHT-WATER-COOLED NUCLEAR POWER REACTOR[a]

Normal conditions of transport

Parameter	Impact
Heat (per irradiated fuel cask in transit)	250,000 Btu/hr
Weight (governed by Federal or State restrictions)	
Per truck	73,000 lb
Per rail car	100 tons per cask
Traffic density	
Truck	Less than 1 per day
Rail	Less than 3 per month

Exposed population	Estimated no. of persons exposed	Range of doses to exposed individuals[b] (millirems) per reactor per year	Cumulative dose to exposed population[c] (man-rems) per reactor per year
Transportation workers	200	0.0-300	4
General public			
Onlookers	1,100	0.003-1.3	3
Along Route	600,000	0.0001-0.06	

Accidents in transport

Source of risk	Environmental risk
Radiological effects	Small[d]
Common (nonradiological) causes	1 fatal injury in 100 reactor-years 1 nonfatal injury in 10 reactor-years $475 property damage per reactor-year

[a]Data supporting this table are given in the Commission's "Environmental Survey of Transportation of Radioactive Materials To and From Nuclear Power Plants," WASH-1238, December 1972.

[b]The Federal Radiation Council has recommended that the radiation doses from all sources of radiation other than natural background and medical exposures should be limited to 5,000 millirem per year for individuals as a result of occupational exposure and should be limited to 500 millirem per year for individuals in the general population. The dose to individuals due to average natural background radiation is about 130 millirem per year.

[c]Man-rem is an expression for the summation of whole-body doses to individuals in a group. Thus, if each member of a population group of 1,000 people to receive a dose of 0.001 rem (1 millirem), or if 2 people were to receive a dose of 0.5 rem (500 millirem) each, the total man-rem dose in each case would be 1 man-rem.

[d]Although the environmental risk of radiological effects stemming from transportation accidents is currently incapable of being numerically quantified, the risk remains small regardless of whether it is being applied to a single reactor or a multireactor site.

5.4.2.6 Summary of Annual Radiation Doses

The annual population doses (man-rem) resulting from the plant operation is presented in Table 5.6. As shown in this table, the operation of the Palisades Plant will contribute a small fraction of the population dose that persons living in the U.S. normally receive from natural background.

5.5 EFFECTS OF THE URANIUM FUEL CYCLE

The environmental effects of uranium mining and milling, the production of uranium hexafluoride, isotopic enrichment, fuel fabrication, reprocessing of irradiated fuel, transportation of radioactive materials and management of low-level wastes and high-level wastes are within the scope of the NRC report entitled, "Environmental Survey of the Uranium Fuel Cycle." (WASH-1248 December 1972) The contribution of such environmental effects are summarized in Table 5.8.

The NRC staff may subsequently modify or expand the discussion of environmental effects of the fuel cycle in the light of the Court of Appeals decision in Natural Resources Defense Council v. NRC (CADC Nos. 74-1385 and 74-1586 decided July 21, 1976). That decision is now being analyzed by the staff.

Table 5.8 Summary of Environmental Considerations for Uranium Fuel Cycle (normalized to model LWR annual fuel requirement)

Natural resource use	Total	Maximum effect per annual fuel requirement of model 1,000 MWe LWR
Land (acres)		
Temporarily committed	63	
Undisturbed area	45	
Disturbed area	18	Equivalent to 90 MWe coal fired power plant
Permanently committed	4.6	
Overburden moved (millions of megatons)	2.7	Equivalent to 90 MWe coal fired power plant
Water (millions of gallons)		
Discharged to air	156	≈2% model 1000 MWe LWR with cooling tower
Discharged to water bodies	11,040	
Discharged to ground	123	
Total	11,319	<4% of model 1000 MWe LWR with once through cooling
Fossil fuel		
Electrical energy (thousands of MW hour)	317	<5% of model 1000 MWe LWR output
Equivalent coal (thousands of megatons)	115	Equivalent to the consumption of a 45 MWe coal fired power plant
Nati al gas (millions of scf)	92	<0.2% of model 1000 MWe energy output
Effluents chemical (megatons)		
Gases (including entrainment)[a]		
SO_2	4,400	
NO_x[b]	1,177	Equivalent to emissions from 45 MWe coal fired plant for a year
Hydrocarbons	13.5	
CO	28.7	
Particulates	1,156	
Other gases		
F	0.72	Principally from UF_6 production enrichment and reprocessing. Concentration within range of state standards below level that has effects on human health
Liquids		
SO_4	10.3	From enrichment, fuel fabrication, and reprocessing steps. Components
NO_3	26.7	that constitute a potential for adverse environmental effect are present
Fluoride	12.9	in dilute concentrations and receive additional dilution by receiving
Ca^{++}	5.4	bodies of water to levels below permissible standards. The constitutents
Cl^-	8.6	that require dilution and the flow of dilution water are:
Na^+	16.9	NH_3 600 cfs
NH_3	11.5	NO_3 20 cfs
Fe	0.4	Fluoride 70 cfs
Tailings solutions (thousands of megatons)	240	From mills only no significant effluer ts to environment
Solids	91,000	Principally from mills no significant effluents to environment
Effluents radiological (curies)		
Gases (including entrainment)		
Rn 222	75	Principally from mills maximum annual dose rate < 4% of average
Ra 226	0.02	natural background within 5 miles of mill. Results in 0.06 man rem
Th 230	0.02	per annual fuel requirement
Uranium	0.032	Principally from fuel reprocessing plants whole body dose is 6
Tritium (thousand)	16.7	man rem per annual fuel requirements for population within 50 mile
Kr 85 (thousands)	350	radius. This is <0.007% of average natural background dose to this
I 129	0.0024	population. Release from Federal Waste Repository of 0.005
I 131	0.024	Ci/year has been included in fission products and transuranics total
Fission products and transuranics	1.01	
Liquids		
Uranium and daughters	2.1	Principally from milling included in tailings liquor and returned to ground no effluents, therefore, no effect on environment
Ra 226	0.0034	From UF_6 production concentration 5% of 10 CFR 20 for total
Th 230	0.0015	processing of 27.5 model LWR annual fuel requirements
Th 234	0.01	Fro fuel fabrication plants concentration 10% of 10 CFR 20 for total processing 26 annual fuel requirements for model LWR
Ru 106	0.15[c]	From reprocessing plants maximum concentration 4% of 10 CFR
Tritium (thousands)	2.5	20 for total reprocessing of 26 annual fuel requirements for model LWR
Solids (buried)		
Other than high level	601	All except 1 Ci comes from mills included in tailings returned to ground no significant effluent to the environment. 1 Ci from conversion and fuel fabrication is buried
Effluents – thermal (billions of Btu)	3,360	<7% of model 1000 MWe LWR
Transportation (man rem) exposure of workers and general public	0.334	

[a] Estimated effluents based upon combustion of equivalent coal for power generation.
[b] 1.2% from natural gas use and process.
[c] Cs 137 (0.075 Ci/AFR) and Sr 90 (0.004 Ci/AFR) are also emitted.
Source: *Federal Register*, Docket 74-9076, filed April 19, 1974, 8:45 am

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POOR ORIGINAL

REFERENCES FOR SECTION 5

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1a. Palisades Plant Abnormal Occurrence Report #AO-12-75 dated June 13, 1975.

2. USEPA, "Steam Electric Power Generating Point Source Category Effluent Guidelines and Standards," FR, Vol. 39, Number 196, Part III, pp. 36186-36207, October 8, 1974.

3. C. Harter, Environmental Noise Survey: Palisades Plant and Cooling Towers; Research and Testing Lab Report No. 1-7A-750801.

4. L. L. Beranek, ed., Noise and Violation Control, McGraw-Hill, 1971.

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6. USEPA, Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin for Safety, USEPA Report No. 550/9-74-004, March 1974.

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19. J. C. Keesey and F. S. Letcher, "Thresholds of Electric Shock at Power Transmission Frequencies," Arch. Env. Health, 21:547, 1970.

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21. "Radioactivity in the Marine Environment," Panel on R.I.M.E. of the Committee on Oceanography, NAS-NRC, 1971.

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30. Brungs, W. A, "Effects of Residual Chlorine on Aquatic Life", WPCF, Volume 45, p. 2180, 1973.

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6. ENVIRONMENTAL MEASUREMENTS AND MONITORING

RÉSUMÉ

The FES describes the applicant's radiological environmental monitoring program, which is further defined in the Technical Specifications for the plant. Amendment No. 6 (dated August 30, 1974) added nonradiological technical specifications to the radiological technical specifications. The NPDES permit was issued on December 27, 1974. In the pages below, the staff reviews the applicant's environmental monitoring program and makes recommendations where appropriate.

6.1 CHEMICAL EFFLUENT MONITORING

The applicant is currently monitoring the plant discharge in accordance with the provisions of the NPDES permit issued to the applicant on December 27, 1974, and the Environmental Technical Specifications issued by the staff for the period of the Provisional Operating License (incorporated as Amendment No. 6 to the Provisional Operating License No. DPR-20).

The staff has reviewed the results of monitoring conducted under the permit and license during the period of closed cycle operation of the plant (January 1, 1975 to date). There have been instances in April, May and June of 1975, for which the limitations on total suspended solids and pH have been violated as well as the possible violation in ETS chlorine concentration limits (but not the NPDES limit) in the blowdown as explained in Section 5.3.1.1. The ETS requires the applicant to analyze the damage done, if any, when a Specification is violated, to determine the cause, and to take corrective action to prevent repeated violations. These activities will be reported in the next semiannual report of operations. In addition, the staff recommends that the chlorine monitoring program described in Section 5.3.1.1 be completed.

6.2 AQUATIC MONITORING

The applicant's monitoring plans for aquatic biota during cooling tower operation are contained in the applicant's proposed technical specifications. Impingement monitoring and visual fish monitoring during and after chlorination will be conducted.

Fish collected on the intake screens will be examined weekly. Impinged organisms will be identified, counted and the length measured. Although impingement was monitored daily during once-through operation, the weekly counts will allow for an evaluation of reduction in impingement associated with the reduced flow. Gross effects on fish populations residing in the vicinity of the discharge will be visually monitored during and after chlorination.

The staff concurs with these plans and recommends that the planned studies be carried out.

6.3 TERRESTRIAL MONITORING

6.3.1 Acoustic Monitoring

The staff has reviewed the operational phase of the acoustic monitoring done at the Palisades Plant (Section 5.3.3.1). This monitoring was undertaken during the spring and summer conditions and consisted of measurements at several locations in and around the site. The sound pressure levels recorded indicate to the staff that activity interference offsite due to plant operation is not likely. However, the measurements are instantaneous and do not represent samples from time periods of sufficient duration to allow calculation of statistically important parameters such as the L_{10} (sound pressure level exceeded 10% of the time), L_{50}, L_{90} or L_{eq} for both day and night periods. Calculations of these parameters would allow comparison with the recent USEPA "identified level" for activity interference.[1]

6.3.2 Fogging, Icing, Moisture

The staff noted in the FES[2] that potential icing and drift deposition may be associated with mechanical draft cooling towers. The applicant has initiated a terrestrial monitoring program[3]

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to determine the effects of ice and drift deposition from its mechanical draft cooling towers on sensitive dune-stabilizing plant communities. Quadrants plots have been established to determine plant species composition changes from drift salts and icing. For arboreal species, monthly observations during the w 'er in the vicinity of each plot will assess physical ice damage. The applicant also periodically procures aerial and ground photographs of the site. During the baseline cooling tower drift study, slides of all major plant communities were taken. These will be compared to photographs of these areas taken during cooling tower operation. The applicant and the staff concur that such photographs will aid in monitoring the overall effects on dune vegetation communities. The First Annual Report of Operation[4] indicates that there were several episodic occurrences of icing on site. Severest damage occurred in close proximity to the towers. The most common type of damage was the shearing of the tree tops. Secondary damage due to the falling tops was also evident. Ground vegetation appeared to be confined to within 50 yards from the towers. The effects of this episodic icing on dune grass was unknown at the time of reporting. The staff concludes from these preliminary data that continued monitoring of the episodic occurrences of icing may indicate selective damage to certain types of tree and shrub species. However, these data do not indicate that such vegetation damage will cause unacceptable destruction to the dune stabilizing plant communities. Twelve months of data on vegetation and soil chemical analysis pertaining to operation of the cooling towers are too inclusive to determine whether possible increases in plant tissue chemical concentrations are due to cooling tower operation. The program will be continued to acquire additional data.

The applicant states that the orchard growers' concern of potential increases in local moisture regimes have been pursued by applicant representatives. The applicant investigated the feasibility of a baseline monitoring program using leaf wetness recorders to determine effects of cooling moisture on local moisture regimes. This program was not undertaken by the applicant, because it was concluded that meaningful data could not be obtained. The staff concurs with this assessment.

Present monitoring programs (including relative humidity and temperature data) established by the applicant in cooperation with the University of Michigan will most likely not be sensitive enough to be able to distinguish any local offiste changes due to the cooling towers operation because they are so small that they would be obscured by normal background variations. The staff believes that only a decided change (>10%) would be seen and such a change is not expected to occur.

The staff <u>recommends</u> that the applicant undertake a survey program to assess impacts of cooling tower moisture on yield, quality and disease control measures upon local orchard crop production. The staff <u>recommends</u> that the applicant survey cooperative growers operating inside and outside the expected drift field for possible effects. Such an annual survey could determine from past and present records of cooperating growers any significant differences in spraying frequencies, quality of crops and yield between selected paired growers within and outside the expected drift field. Results should be included in the applicant's annual environmental monitoring report.

6.3.3 Herbicides

The staff <u>recommends</u> that the applicant report the date, type, mode and rate of application, location, and restrictions or conditions of use of each herbicide application along its transmission corridors. The staff also <u>recommends</u> that the applicant conduct inspections to confirm that restricted areas have not been sprayed, unauthorized releases have not taken place, and accidents such as spills have been documented (and cleaned up if possible). Field logs should be kept of these inspections.

6.4 METEOROLOGICAL MONITORING

The topography of the site is extremely complex, with numerous sand dunes randomly oriented between the plant and the site boundaries. The complex topography makes the estimation of plume dispersal and transport beyond the site boundary very difficult.

Several onsite meteorological towers have been used to collect data since 1968. The original (1968) shoreline tower, a 55-ft utility pole located atop a sand dune about 150 feet above lake level, about 700 feet from the shoreline, and less than 200 feet the reactor building, was decommissioned in late 1971. The present shoreline tower, also a 55-ft utility pole, is located atop a tree-covered sand dune overlooking the Visitors Center, about 125 feet above lake level and about 700 feet east-northeast of the reactor building. Deciduous trees, about 40 feet high, completely surround this tower, and when the trees are in leaf, the lower Delta-T sensor is well within the tree canopy. Wind speed and direction are measured at the 55-ft level of the tower using a Bendix Aerovane (starting threshold about 0.75 mph), and vertical temperature gradient

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is measured between the 10-ft and 55-ft levels using Rosemount temperature sensors. The lower Delta-T sensor and shield are improperly pointed skyward. The initiation date for this tower is not clear. Since August 1973, data from this tower are available on magnetic tape.

The applicant has provided, at our request, five joint frequency distributions of wind speed and direction by atmospheric stability utilizing the only available onsite data. Atmospheric stability was defined by several criteria: the standard deviation of the fluctuations of horizontal wind direction (sigma-theta); vertical temperature difference between 10-ft and 55-ft; and vertical temperature difference between 10-ft and 55-ft "corrected" to approximate the standard vertical temperature difference measurements between 10m and 40m by multiplying a correction factor of 0.81. We have examined all of the available onsite data (including the 5 sets of joint frequency distributions) and have decided that the onsite joint frequency distributions of wind speed and direction measured at the 55-ft level (by the low-threshold sensor) by atmospheric stability, defined by sigma-theta when wind speeds were greater than 2 mph and by vertical temperature difference between 10-ft and 55-ft (uncorrected) when wind speeds were less than or equal to 2 mph, for the one year period 9/1/73 - 8/31/74, are the best available data. The recovery for this data set was 67%.

We have used these data to provide estimates of annual average relative concentration (X/Q) values for the site. A Gaussian diffusion model with adjustments for building wake effects, described in Regulatory Guide 1.42, was used to make estimates of relative concentration at various distances and directions. Although the recovery for this data set was only about 67%, the wind rose appears reasonable, and the annual average relative concentration values, calculated at the specified points of interest calculated using these data, appear reasonably conservative when compared to similar calculations using meteorological data available from the D. C. Cook nuclear facility, located about 30 miles south of the Palisades site, also along the Lake Michigan shoreline in similar topography.

However, based on examination of local topography and a comparison of 4 months of wind data from the onsite tower with concurrent data from a 10-ft mast located about 1 mile southeast of the plant, the location of the present tower provides measurements representative of localized conditions which are not representative of transport and diffusion conditions expected at or beyond the site boundaries. Therefore, to permit verification of the relative concentration values calculated using data from this tower, it is our recommendation that: 1) the applicant submit for our approval proposed modifications to the present onsite meteorological measurements program that will provide meteorological data representative of conditions at both the point of release and at the inland site boundaries; 2) instrumentation on all meteorological towers(s) should meet the recommendations of Regulatory Guide 1.23 unless the applicant can demonstrate that deviations from these recommendations are warranted; and 3) the applicant submit one year of additional meteorological data, with greater than 90% data recovery, from the modified measurements program as soon as these data are available. An estimated date for final verification would be early 1977, depending on the schedule of modifications to the present onsite meteorological program by the applicant and collection of one full year of data from the new program with acceptable data recovery. We anticipate that this verification will confirm our conclusions, and that any modifications to our conclusions can be implemented through changes in the Environmental Technical Specifications.

6.5 RADIOLOGICAL MONITORING

There are discrepancies between the licensee's current monitoring program and that outlined in Regulatory Guides 1.21, 4.1, and 4.8. It is recommended that new technical specifications be written for the full term license which will be in accord with these Regulatory Guides, unless the applicant can demonstrate that deviations from these guides are warranted.

REFERENCES FOR SECTION 6

1. Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety; USEPA Report No. 550/9-74-004; March 1974.

2. USAEC, "Final Environmental Statement, Palisades Nuclear Generating Plant," Docket No. 50-255, p. V-69-70, June 1972.

3. Consumer Power Company. Palisades Nuclear Generating Plant. Amendment No. 6, Change No. 10 to the Technical Specifications, App. A. August 30, 1974.

4. First Annual Report of Operation for the Palisades Plant, January 1, 1975 to December 31, 1975; Consumers Power Company; March 5, 1975.

7. NEED FOR ADDITIONAL POWER FROM UPRATING

RÉSUMÉ

Since the FES Section X discussion assumes an electrical power output of approximately 700 MWe, this section of this addendum considers the need for an additional 100 MWe of power.

7.1 DESCRIPTION OF THE SYSTEM

The applicant is engaged in the generation, distribution, and sale of electric energy and in the distribution and sale of natural gas. With respect to its electric operations, the applicant serves more than 1.1 million customers within a service area of 27,826 square miles constituting the greater portion of Michigan's Lower Peninsula outside of the Detroit area.[1] The applicant is interconnected with The Detroit Edison Company, with which it jointly plans capacity additions and removals and maintains pooled operations. In 1974, Detroit Edison had 1.6 million customers located in the Detroit metropolitan area and immediately surrounding communities.[2] Together these two companies constitute the Michigan Electric Coordinated System (MECS), and are members of the East Central Area Reliability Coordination Agreement (ECAR).

Objectives of pooled operation include spreading of risk, thereby improving financial and system reliability, through joint ownership of generating capacity within a larger system. In addition to pooled operation and membership in ECAR, the applicant and Detroit Edison have, in the past, relied upon contract for diversity exchanges with Ontario Hydro. However, no long-term contracts are presently in effect or anticipated for the future.[3]

As of December 31, 1974, the applicant's net demonstrated capacity was 5,350 MWe and that of the Detroit Edison Company was 9,240 MWe for an MECS grand total of 14,590 MWe.[4] Karn 3, a 644 MWe oil-fired load following unit, was placed on line in the first quarter of 1975. Karn 4, another load following oil-fired unit of 663 MWe, is scheduled to begin operation in the fourth quarter of 1976.[5] The applicant plans no further additions through 1980. Detroit Edison has tentative plans to bring a 780 MWe oil-fired unit on line in 1978 and a 1,093 MWe nuclear unit on line in 1980.

7.2 NEED FOR BASE-LOAD GENERATING CAPACITY

7.2.1 Trends and Forecasts for Load and Energy

Applicant and Michigan Electric Coordinated System summer and winter peak loads and generating requirements, historic 1965 through 1974, and forecast 1975 through 1980, are shown in Table 8.1. The forecast for 1975 and later have been revised downward by the applicant since the previous forecast in 1973. The forecasts as of March 4, 1975, shown in Table 7.1, reflect average compound rates of growth in the range of 5.5 percent to 6.0 percent. A study by the Michigan Public Service Commission concluded that the average compound growth rates of the applicant and Detroit Edison forecast of growth in peak load are likely about one percent too low.[6]

7.2.2 Need for Base Load

On the basis of load duration analysis, the applicant estimates that a minimum of 50 percent of its generating capacity is required to be base load.[7] Using a 1975 peak lo[illegible]10 MWe, forecast previously, the applicant's required base load generation capaci[illegible]ited to be 3,125 MW. Base load units on line in 1975 totaled 2,953 MWe.[9] Adding th[illegible]isades uprate would bring this total to 3,053 MWe, which is slightly lower than th[illegible] based load capacity. In addition, as peak load and generating requirements increase [illegible]emainder of this decade, the deficiency in base load generating capacity will further de[illegible]te. Additional base load capacity cannot be added to the applicant's system before 1980.[10]

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TABLE 7.1

HISTORIC AND PROJECTED PEAK LOADS AND GENERATION REQUIREMENTS 1965-1980

Year	Consumer's Power			Michigan Electric Coordinated System		
	Summer Peak-MWe	Winter Peak-MWe	Gen. Req. GWh	Summer Peak-MWe	Winter Peak-MWe	Gen. Req. GWh
1965	2,377	2,570	14,538	6,085	6,526	39,913
1966	2,522	2,870	15,891	6,530	7,099	40,595
1967	2,673	2,941	16,665	7,080	7,280	42,276
1968	2,979	3,180	18,111	7,808	7,833	46,286
1969	3,184	3,377	19,435	8,320	8,435	49,738
1970	3,343	3,458	20,095	8,751	8,494	51,253
1971	3,604	3,711	21,509	9,573	9,010	54,571
1972	3,808	4,080	23,330	9,743	9,683	58,946
1973	4,394	4,105	25,212	11,265	9,630	63,047
1974	4,109	4,033	24,626	10,709	9,417	60,620
1975	4,290	4,360	25,311	11,290	10,010	59,511
1976	4,550	4,600	26,726	11,950	10,550	63,126
1977	4,810	4,870	28,162	12,660	11,170	66,962
1978	5,100	5,140	29,660	13,450	11,790	70,980
1979	5,380	5,420	31,206	14,280	12,420	75,106
1980	5,710	5,710	32,957	15,160	13,110	79,657

NOTE: 1965-1974 actual 1975-1980 forecast

SOURCE: ER, Amendment No. 28, Section 7.1, Table I-1 and Supplement dated April 25, 1975, p. 11.

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REFERENCES FOR SECTION 7

1. Consumers Power Company, Environmental Report, Request for Full-Term Operating License and Application for an Increase in Power Level, Palisades Unit No. 1, Amendment 28, U.S. Nuclear Regulatory Commission, Docket No. 50-255, January 22, 1974, Section 1, p. 1.

2. The Detroit Edison Company, Annual Report-1975, p. 10.

3. Environmental Report, Section 7, p. I.2.

4. East Central Area Reliability Coordination Agreement, Volume I, Load Projections and Resource Planning, A report by ECAR Bulk Power Members to the Federal Power Commission Pursuant to Docket R-362, Order 383-3, April 1975, Exhibit I-1, Table III.

5. Ibid., Table IV.

6. Michigan Public Service Commission, "Evaluation of the Consumers Power and Detroit Edison-1974 Load Growth Forecasts," M.P.S.C. Staff Study 1975-1, February 1975, p. 2-1.

7. Environmental Report Supplement, January 15, 1975, p. 3.

8. Ibid, p. 6.

9. Ibid., p. 9.

10. Ibid., p. 10.

IMAGE EVALUATION
TEST TARGET (MT-3)

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8. EVALUATION OF THE PROPOSED ACTION

8.1 ADVERSE EFFECTS WHICH CANNOT BE AVOIDED

The staff has reassessed, at the increased power level proposed, the physical, social, and economic impacts that can be attributed to the Palisades Nuclear Generating Plant. The staff has not identified additional adverse effects that will be caused by operation of the plant, but the possibility exists for impacts from chlorine releases, cooling tower moisture, drift salts, and icing. Monitoring programs will be required to detect any significant impacts which occur. Other monitoring requirements, including an improved meteorological program, will be established to verify staff predictions.

The staff has reviewed the provisional operating license and the environmental conditions contained in it, and the staff has concluded that the environmental license conditions have been met by the licensee.

Maintenance of dunes disturbed by cooling tower construction and maintenance of transmission lines and rights of way will be performed so as to minimize environmental impacts from construction and operation of the plant.

8.2 SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

The staff's evaluation of the use of land for the site of the Palisades Plant and associated transmission lines has not changed since the environmental review which resulted in the FES. The presence of this plant in Van Buren County will continue to influence the future use of other land in its immediate environs as well as the continued removal of county land from agricultural use as the result of any increased industrialization.

8.3 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

There has been no change in the staff's assessment of this impact since the earlier review.

8.4 DECOMMISSIONING AND LAND USE

In the long-term, beyond the useful life of the proposed generating station, this site may continue to be used for generation of electrical energy. At the termination of such use, the land areas occupied by the nuclear facilities would be removed from productive use, unless decommissioning measures included removal of all radioactive equipment. Although the details of decommissioning may not be worked out for several years, the various alternatives should not be diminished by the proposed action of licensing operation. The range of beneficial uses of the site by future generations will not be curtailed, provided the applicant has the capability for removing all radioactively contaminated equipment if and when that step may be desirable.

NRC regulations prescribe procedures whereby a licensee may voluntarily surrender a license and obtain authority to dismantle a facility and dispose of its parts.[1] Such authorization would normally be sought near the end of the nuclear plant's useful life. In any event, the Commission requires that a qualified licensee maintain valid licenses appropriate to the type of facility and materials involved. Under current regulations, the Commission generally requires that all quantities of source, special nuclear, and byproduct materials not exempt from licensing under Parts 30, 40, and 70 of Title 10, Code of Federal Regulations, either be removed from the site or secured and kept under surveillance.

To date, experience has been gained with decommissioning of six nuclear electric generating stations which were operated as part of the Atomic Energy Commission's power reactor development program: Hallam Nuclear Power Facility, Piqua Nuclear Power Facility, Boiling Nuclear Superheat Power Station, Elk River Reactor, Carolinas-Virginia Tube Reactor, and Pathfinder Atomic Power Plant. The last two facilities were licensed under 10 CFR Part 50; the others were Atomic Energy Commission-owned and operated under the provisions of Part 115.

Several alternative modes of decommissioning have been experienced in those cases. They may be summarized generally as four alternative levels of restoration of the plant site, each with a distinct level of effort and cost.

In decommissioning at any level, economically salvageable equipment and all reactor fuel elements would be removed, some equipment would be decontaminated, and wastes of the type normally shipped during operation would be sent to waste repositories. In addition, the respective levels of restoration would involve the following measures:

Lowest level. There would be minimal dismantling and relocation of equipment. All radioactive material would be sealed in containment structures (primarily existing ones), which would require perpetual, continual surveillance for security and effectiveness.

Second level. Some radioactive equipment and materials would be moved into existing containment structures to reduce the extent of long-term contamination. Surveillance as in the lowest level would be required.

Third level. Radioactive equipment and materials would be placed in a containment facility approaching a practically minimum volume. All unbound contamination would have been removed. The containment structure would be designed to need minimal perpetual maintenance, surveillance, and security.

Highest level. All radioactive equipment and materials would be removed from the site. Structures would be dismantled and disposed of onsite by burial or offsite to the extent desired by the tenant. No further Commission license would be required.

Estimated costs of decommissioning at the lowest level are about $1 million plus an annual maintenance charge on the order of $100,000.[2]

Complete restoration, including regrading, has been estimated to cost $70 million.[3] Hence, there is wide variation, arising from differing assumptions as to level of restoration. At present land values, it is not likely that consideration of an economic balance alone would justify a high level of restoration. Planning required of the applicant at this stage will assure, however, that variety of choice for restoration is maintained until the end of useful plant life.

The Palisades Plant is designed to operate for about 30 years, and the end of its useful life will be approximately in the year 2002. The applicant has made no firm plans for decommissioning but assumes that the following steps would be taken as minimum precautions for maintaining a safe condition.

1. All fuel would be removed from the facility and shipped offsite for disposition.

2. All radioactive wastes - solid, liquid, and gas - would be packaged and removed from the site insofar as practical.

A decision as to whether the facility would be further dismantled would require an economic study involving the value of the land and scrap value versus the cost of complete demolition and removal of the complex. However, no additional work would be done unless it is in accordance with rules and regulations in effect at the time.

In addition to personnel required to guard and secure the station, concrete and steel would be used to prevent ingress into any building, particularly the radioactive areas.

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REFERENCES FOR SECTION 8

1. Title 10, "Atomic Energy," Code of Federal Regulations, Part 50, Licensing of Production and Utilization Facilities, Section 50.82, "Applications for Terminations of Licenses."

2. Atomic Energy Clearing House, Congressional Information Bureau, Inc., Washington, D.C., 17(6):42, 17(10):4, 17(18):7, 16(35):12.

3. "Pacific Gas and Electric Company, Supplement No. 2 to the Environmental Report, Units 1 and 2, Diablo Canyon Site," July 28, 1972.

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9. BENEFIT-COST ANALYSIS

RÉSUMÉ

Since the FES Section XI discussion assumes an electrical power output of approximately 700 MW, this section of this addendum compares the alternative ways of providing the additional 100 MWe of power that would be provided by the Palisades power uprate.

9.1 COST OF ALTERNATIVE SOURCES OF BASE-LOAD CAPACITY

Palisades is presently the least costly base load facility in the applicant's system on the basis of fuel and operation and maintenance costs per kWh of output. This favorable cost position and the fact that Palisades is now operating at 100 MWe under capacity makes Palisades the least expensive source of an additional 100 MWe capacity. Even in the highly improbable event of no future growth in the need for base load capacity, it would be economical to uprate Palisades by 100 MWe at the expense of another higher cost base load unit.

Fuel and operation and maintenance costs for each of the applicant's base load are shown in Table 9.1. These costs are 5.04 mills/kWh at Palisades compared to 8.46 mills/kWh at Campbell 1 & 2, the next least expensive units. For the seven ba load stations on the applicant's system, fuel and operation and maintenance costs range rom a low of 5.04 mills/kWh to 16.05 mills/kWh. For fi the seven stations, these costs are more than twice as great for Palisades. It is clea that the additional 100 MW capacity of Palisades will produce energy more cheaply th can any other existing base load plant.

TABLE 9.1

FUEL AND OPERATION AND MAINTENANCE COSTS FOR APPLICANT'S BASE LOAD UNIT

Units	Capacity MW	Cost mills/kWh
Palisades	686[a]	5.04
Campbell 1 & 2	647	8.46
Big Rock Point	71	10.18
Cobb 4 & 5	327	11.58
Karn 1 & 2	550	12.16
Weadock 7 & 8	327	12.67
Whiting 1-3	345	16.05

SOURCE: Consumers Power Company, Environmental Report, Request for Full-Term Operating License and Application for an Increase in Power Level, Palisades Unit No. 1, Amendment 28, U.S. Nuclear Regulatory Commission, Docket No. 50-255, January 22, 1974, Supplement dated January 15, 1975, p. 7.

[a]Capacity at which Palisades is presently authorized to operate. Designed capacity 786 MW.

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The feasibility of purchasing equivalent base load capacity and energy from other utilities in the United States and Canada has been explored by the applicant, and discounted on the basis of both cost and likely difficulty of obtaining long-term contracts. The price of purchase power will be considerably higher than the cost of power from Palisades and will likely be higher than the cost of the most costly base load unit on the applicant's system. The applicant and Detroit Edison have a joint agreement with Ontario Hydro for short notice transfer of surplus power when needed by the applicant and Detroit Edison and when available from Ontario Hydro.[1] The applicant does not consider it prudent to develop long-term arrangements with Ontario Hydro for the purchase of power tc replace base load. The overriding consideration, however, is again one of cost. The applicant has estimated during 1975 the purchase of an addition 100 MWe of power from Ontario Hydro would cost $12 million compared wtih the $2.5 million cost of power from Palisades for fuel plus operation and maintenance.[2]

9.2 OTHER BENEFITS

9.2.1 System Reliability

In addition to aiding the applicant in moving toward a desired base load capacity, the Palisades uprating will improve the MECS reserve margin by a fraction of a percentage point. The applicant and Detroit Edison have a reserve margin target of 20 percent of peak load corresponding to a once-in-twenty years loss of load.[3] Reserve at summer peak is projected to decline from an estimated 27.7 percent for 1975 to 8.9 percent by 1980.[4]

9.2.2 Fossil Fuel Savings

The applicant estimates that the Palisades uprate wil save 50,000 tons of coal and 1,000,000 barrels of oil which would otherwise be consumed each year to fire fossil units on its system.[5] This reduction in consumption of fossil fuel will prevent release of 230,000 pounds per year of particulate matter and 8.5 million pounds per year of SO_2 emissions.

9.3 SUMMARY OF BENEFIT-COST

In this review of potential environmental, economic, and social impacts, no new information has been acquired that would alter the staff's previous position related to the overall balancing of the benefits of this plant versus the environmental costs. Consequently, it is the staff's belief that this plant can continue to be operated with only minimal environmental impacts. The staff finds that the primary benefits of the addition to base load generating capacity and minimizing system production costs greatly outweigh the environmental and social costs.

The staff has assessed the need for an additional 100 MWe of base load power on the applicant's system and has examined the relative costs of various alternative sources of base load power. An additional 100 MWe output from Palisades has been shown, on the basis of direct cost, to be cost justified regardless of whether an additional 100 MWe of capacity is required. Additional benefits from increased system reliability and lower levels of air pollutant will also be realized.

REFERENCES FOR SECTION 9

1. Environmental Report Supplement, January 15, 1975, p. 5.
2. Ibid., p. 5.
3. Environmental Report, Section 7, p. I.5-6.
4. ECAR, Volume I, Exhibit I-L, pp. 12, 13.
5. Environmental Report Supplement, January 15, 1975, p. 4.

APPENDIX A

(Reserved for comments on draft addendum)

APPENDIX B

This Appendix describes the models and assumptions used to make upper bound estimates of population dose for interim assessment of the potential radiological impact from normal operation of nuclear power stations in the United States.

Dose Definitions

Individual doses from specific radionuclides were estimated using standard internal dosimetric techniques in accordance with the recommendations of ICRP.[1,2,3] All internal dose conversion calculations have been made using the maximum permissible concentrations listed in ICRP publications II and VI. Data on breathing rates, organ masses, and other physiological parameters are those implied by the standard man of ICRP II.

The isotopic concentration levels in the environment used in the dose calculations were conservatively assumed to be those which would exist during the final year of plant life. A 30-year plant operational lifetime was assumed for calculating buildup of long-lived activity in the environment. Calculated doses represent a 50-year dose commitment which would be received by the population during one year of exposure to radioactive releases from the facility at the levels described; that is, the calculated doses reflect the dose that a person would receive over fifty years from radioactive materials to which that person was exposed for one year. For isotopes with a short effective half life, the exposure essentially all occurs in the year of the intake. For isotopes with a longer effective half life, the dose resulting from intake in any one year may be spread over a long period. The 50-year dose commitment method computes the dose associated with any given year's intake, even if that dose is due to a long-lived isotope and is spread out over the lifetime of the person exposed.

Receiving Water

The liquid effluent population doses previously used by the staff were conservative. For example, fish were assumed to have come to equilibrium with the radioactivity content of the water in which they were caught. Thus, the man-rem developed previously has been accepted for this evaluation and incorporated into the sum. In any case, the liquid effluents contribute only small fractions of the total impact of the station.

Atmospheric Effluents

For a uniform population density the population dose may be written as

$$\text{Population dose} = K \bar{\Psi} P$$

where $\bar{\Psi}$ is the spatially averaged concentration time integral appropriate for a population of P individuals.

Atmospheric Effluents Which Deposit (Radioiodine and Particulates)

At any point, the concentration time integral Ψ, will be related to the ground concentration w, and the deposition velocity, V_g, by

$$V_g = w/\Psi$$

Thus, the population dose can be expressed as

$$\text{Population dose} = K \bar{W} P/V_g$$

where $\bar{W}$ is the average ground concentration appropriate for the population P. In the above equation only the average ground concentration, $\bar{W}$, is needed. Noting that whatever is released will eventually settle, we can define the average $\bar{W}$ over a large arbitrary area as

$$\bar{W} = Q/A$$

where Q is the total source released. This gives

Population dose = K Q P/A V_g

where P/A is the average population density (people per square meter), Q is the total source released (curies), V_g is the deposition velocity (meters per second) and K is the dose conversion factor (rem per Ci-sec/m³). The above equation was used to determine upper bound population doses for the generic case.

The doses resulting from ground plane irradiation of the population were primarily based on the Oak Ridge EXREM III Code.[4] Data on certain other isotopes were based on Battelle studies.[5] Basically, the method used consists of determining the gamma energy at 100 cm above an assumed infinite ground plane. Buildup of long-lived activity on the ground from 30 years of continuous deposition includes ingrowth of daughter products. No beta doses from ground plane irradiation were treated, as vegetation on the ground, clothing, and the travel distance in air all combine to make this dose contribution very small. In any case, the contribution to the total U.S. population dose from ground plane radiation is negligible.

Food Uptake

For exposure from airborne radioisotopes resulting from food uptake, the population exposure is determined not by the density of people in the area of the food crop, but by the number of persons that can be fed by the affected crop. We have considered the exposure associated with three principal pathways. direct ingestion of affected vegetation; consumption of meat from animals fed on affected vegetation; consumption of milk from animals fed on affected vegetation.

For our interim estimates, ground deposition was computed as described above. Vegetation density used was 2,300 grams vegetation per square meter and 440 grams grass per square meter of pasture[6] which is typical of average agricultural and pasture land.

Concentrations of isotopes on the soil assumed buildup of the isotope from continuous deposition over the facility lifetime (30 years). Also included was ingrowth of radioactive daughter products. Isotopes were assumed to be deposited directly on vegetation as well as deposited on soil and taken up by plant roots. No loss of radioisotopes from soil by weathering or other removal mechanisms is included so that the calculated results tend to be conservative.

Concentrations of isotopes directly deposited on vegetation assumed an effective 13-day weathering removal half life from plant leaves in addition to the radiological half life. Since both soil deposition and vegetation deposition are treated assuming the full original airborne concentration (i.e., deposition of isotopes on the soil was not depleted to account for the isotopes deposited on vegetation before they reach the soil), material weathered from the plants to the soil has already been accounted for. Thus the doses do not need to be separately treated. Of the amount directly deposited on vegetation, 30 percent was assumed to be absorbed by the plant.

This results in a computed concentration of radioisotopes in agricultural vegetation in the affected area. For the portion of the vegetation which is assumed to go directly to human consumption, a decay time of 7 days was assumed in the transfer of foodstuffs from the field to ultimate consumption.

In addition to the portion going directly to human consumption, vegetation containing radioisotopes as computed above is assumed to be fed to meat and milk animals. Cattle were assumed to have ingested at a rate equivalent to 200 kg "grass"/day.[7] Assuming a grass dry matter content of 25%, the above rate corresponds to 50 kg dry "grass"/day. This ingestion rate is not to be considered as the daily mass intake of feed, but the "grass equivalent" intake. The development of this estimate is outlined below.

To maintain a high productivity, animals are generally offered feeds, such as grains and harvested forages, to supplement or to totally replace the pasture intake.[7,8,9] The U.S. Department of Agriculture[9] has estimated that one-fifth of the diet of milk cattle is obtained from pasturing. This percentage is based on the "energy requirements" of milking animals.

In evaluating the transport of radioiodine (I-131) in the milk pathway, it is generally accepted that a pasture intake of 10 kg dry grass/day is applicable.[10-12] Assuming the energy content of various feeds are equivalent to grass, the above statement implies a total daily intake rate of 50 kg dry "grass"/day or 200 kg wet "grass"/day. Beef animals were assumed to be subject to the same feeding practices as milk cattle.

equilibrium concentration of tritium in the world, doses to man were calculated by assuming all the hydrogen in the body reaches the same equilibrium ratio of tritum to hydrogen as exists in the air and water of the environment.

Population Density and Changes - Local Impact

The doses calculated for shine dose from radioactive materials deposited on the ground and for short-lived noble gases were based on a population density of 160 persons/sq. mile, characteristic of the U.S. population east of the Mississippi River. These components of dose would be increased if the close-in populations, the populations principally exposed, exceeded this value substantially. However, as noted, these components do not significantly affect the total and would be reviewed on an individual case basis for the Appendix I cost-benefit analysis.

Local food uptake exposures are not based on population density, but, rather, on agricultural productivity, and, consequently, are not directly affected by population growth but more by changes in land use. Similarly, the principal future impact on estimates from liquid effluents would result if water use patterns in the nearby areas are changes, e.g., if a drinking water intake for a large city is constructed near the plant discharge. Such future changes are difficult to predict.

To assure adequate control of releases, allowing for future changes in water or land use, the operating license technical specifications will provide for periodic reassessment of changes in land and water use patterns. This will provide a periodic reassessment of the adequacy of facility performance in order to maintain exposures of the public health within the Appendix I guides.

Conclusions

The main contributions to the population dose to the U.S. is from C-14 and I-131. The generic estimates are about two man-rem/year for C-14 and about 300 man-rem/year for I-131 per curie releases per year of plant operation for 30 years. All other releases and pathways contribute relatively insignificant portions of the total population dose.

For the animal feed coming from stored feeds a two-month delay was assumed, which results in decay of short-lived isotopes. For the portion coming directly from pastureland uptake, no decay was assumed between deposition and animal uptake.

Transfer factors from animal uptake to milk and meat were taken from UCRL-50163, C.Ng et al.[13] For population dose estimates, a one-day milk supply delay factor was used, and a seven-day meat supply delay factor was used between consumption of vegetation by the animal and ultimate consumption of meat or milk from that animal by persons in the population. This gives a concentration of radioisotopes in meat and milk from agricultural lands in the affected area.

To convert from concentration of activity in foodstuffs to population dose, we have assumed that the affected land has an average agricultural productivity equivalent to assuming that the entire U.S. population was fed from the portion of the land area of the U.S. east of the Mississippi. With an average diet for an adult of:

Vegetation	- 400 g/day
Meat	- 250 g/day
Milk	- 350 g/day

This results in an average land productivity of:

Vegetation	- 100 kg/day - mile^2
Meat	- 65 kg/day - mile^2
Milk	- 90 kg/day - mile^2

This compares fairly conservatively with the agricultural land productivity for the U.S. of about 50 kg/day - mile^2 for milk[14] and 10 kg/day - mile^2 for meat.[15]

Atmospheric Releases Which Do Not Deposit (Noble Gases, Carbon-14 and Tritium)

Short-lived noble gases were assumed to disperse to the atmosphere without deposition, but radioactive decay which limits spread of the gas was explicitly treated. The population dose, assuming an infinite integration along the plume pathlength, is given by

$$\text{Population dose} = K\ Q\ P/\lambda L\ A$$

which is the same form as used for particulate deposition, except that the deposition velocity is replaced by λL, where λ is the radioactive decay constant (sec^{-1}) and L is the height of the assumed vertical air mixing. An L value of 1,000 meters was used in the calculations.

The long-lived gaseous radioisotopes, krypton-85 and carbon-14, were assumed to be distributed by dilution in the earth's atmosphere. Both were considered to build up over 30 years of plant life. Carbon-14 was assumed to be released in oxide form which maximizes its availability to the population via food chains. Other chemical forms such as methane would not be as readily available.

The carbon-14 was considered to be completely mixed in the troposphere with no removal mechanisms operating; i.e., the absorption of carbon by the ocean and long-lived biota not strongly coupled to man were neglected. In actuality, the atmospheric residence time of carbon is about 4-6 years[16,17] with the ocean being the major sink. The neglect of carbon sinks yields an overestimate of the steady-state or end of plant life (30 year plant life) atmospheric concentration by a factor of about six.

Unlike radioactivity ejected into the stratosphere and then appearing in the high latitude troposphere as in weapon testing, the emission of concern here is directly introduced into the mid-latitudes of the troposphere. Transfer of tropospheric air between the two hemispheres, although inhibited by wind patterns in the equatorial region, is considered to yield a hemisphere average tropospheric residence time of about two years with respect to hemispheric mixing.[4] This time constant is quite short with respect to the expected plant life time and mixing in both hemispheres can be assumed for end of plant life evaluations.

Doses were calculated assuming all carbon in the body reaches the same equilibrium ratio of carbon-14 to natural carbon as exists in the air.

Tritium

Tritium was assumed to mix uniformly in the world's hydrosphere. The hydrosphere was assumed to include all the atmospheric water and the upper 70 meters of the oceans. Having determined this

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