ILLINOIS POLLUTION CONTROL BOARD
November 23, 1971

In the Matter of	)	
	)	
	)	#R 70-16
	)	
MISSISSIPPI THERMAL STANDARDS	)	

Opinion of the Board (by Mr. Currie):

Existing standards (SWB-12 and SWB-13) limit temperature in the Mississippi River to 90°F., and in any case to no more than 5° above natural temperature, outside a mixing zone extending 600' from the point of a heated discharge. Cf. Application of Commonwealth Edison Co. (Dresden #3), #70-21 (March 3, 1971). The construction of a large nuclear generating station (the Quad-Cities plant of Commonwealth Edison Co. and Iowa-Illinois Gas and Electric Co., slated for operation in the summer of 1971) on the Mississippi at Cordova prompted the filing in December 1970 of a citizen petition, by the Izaak Walton League, proposing that we adopt a new standard for that part of the river, which would abolish the mixing zone, limit effluents to 5° above natural temperatures at the maximum, and provide monthly maximum effluent temperatures that would at times require less than a 5° rise over natural temperatures. We broadened the proposal to apply to the entire Illinois portion of the river and scheduled public hearings.

At about the same time the federal Environmental Protection Agency was reexamining the adequacy of existing standards from the headwaters to the mouth of the Mississippi. At a January meeting in St. Louis, attended by representatives of most of the river states, the federal agency put forward a proposed new set of standards, based upon a maximum 5° rise in the river itself but with monthly maxima, based on existing temperature records and on the needs of the local biota, that were not to be exceeded in the river itself at any time. The monthly maxima increased as one proceeded downstream through several zones of differing natural temperatures. The zone boundaries and the monthly maximum figures were somewhat revised and presented to the states again at a second St. Louis meeting in March. We published the federal proposal as an alternative to be considered in further hearings in this proceeding.

This Board was represented at both the federal meetings in St. Louis, and we have incorporated the transcripts of these meetings in the present record. We held hearings of our own in

Rock Island in February and in Alton in April. Moreover, in February we received an application from Commonwealth Edison and Iowa-Illinois for a permit to operate the new Quad-Cities power station. At Edison's request we agreed to incorporate the evidence on thermal discharges from the permit proceedings into the present record in order to avoid duplication of testimony. The federal agency also offered to present evidence relevant to the standards at the permit hearings, which began in Rock Island May 24 and lasted for eleven days.

After thorough study of the voluminous record, we published a proposed final draft June 28, and a revised final draft proposed on August 13, based upon the federal proposal with several modifications discussed below. As required by our procedural rules, we kept the record open for comments until September 9. After a final consultation with federal and other state officials November 12, we today adopt the regulation in a slightly modified form from the August 13, 1971 draft. The reasons underlying the final regulation follow:

Citizen testimony at the February hearing strongly suggested that, in the absence of regulation, a single large power plant such as Quad-Cities would have a serious adverse effect on the ecology of a substantial portion of the river. Quad-Cities, the record shows, will have two 809-megawatt units and will pour 2270 cubic feet per second of cooling water into the river at a temperature 23°F. warmer than the river (Permit hearing, pp. 32, 763). The seven-day low flow recorded once in ten years at Clinton, Iowa, fifteen miles upstream from Quad-Cities and representative of the Quad-Cities flow, has been 13,200 cfs since the augmentation of low flows from navigation dams in 1939 (Permit hearing, pp. 696-703, 714). The lowest one-day flow in the past 30 years has been 10,900 cfs (id., p. 715). Thus at low water the discharge from Quad-Cities will comprise 1/4 to 1/5 of the entire river flow, and it will be 23° above normal when it reaches the stream.

Quad-Cities will discharge into Pool 14 of the river, which is rich in assorted fish of considerable game and commercial value (Feb. 24, p. 23; p. 81); the value of its sport fishery was estimated at $149,000 per year by the Illinois Department of Conservation (Permit Hearing, P. 2070). Three valuable species in the pool were said to be near the southern limit of their tolerance (Apr. 23, pp. 81, 110). Five species, it was argued, could be seriously affected by a thermal barrier 10-20° above normal temperatures, both because of the floating of drum eggs and fry downstream into areas heated above lethal limits and because of the heating of inshore spawning in areas during seasons when cool water is necessary for reproduction (Feb. 26, pp. 28-20, 46-47). There was evidence from a commercial fisherman that carp and buffalo have moved away from the plume of a much smaller power plant near Genoa, Wisconsin, and that catfish in areas affected by the Genoa plume have failed to spawn (id., pp. 74-78). With recorded natural temperatures approaching 90° on occasion in this part of the river, the effluent itself will sometimes be as warm as 110° (id., pp. 89-90).

The situation depicted by these witnesses, however, is predicated on an absence of any measures to minimize the area of the river affected or to increase the rapidity of mixing. In fact the existing regulations make the extreme results postulated illegal. The power companies had originally planned simply to discharge the heated Quad-Cities effluent at the end of a wing dam into the main river channel, so as to minimize warming of sensitive inshore areas; but a 1970 simulation modeling demonstrated this plan would not meet the existing standard of 5° above natural, with a 90° maximum, at the edge of a 600' mixing zone (Permit hearing, p. 768). Consequently the companies designed and are planning to construct a $6,000,000 diffuser (Permit hearing, p. 1762), a pipe that will extend most of the way across the river bottom and discharge heated water at numerous points to facilitate rapid mixing.

It is the companies' position that by this means they can comply with the existing standard. Downstream, after complete mixing with as little as 10,500 cfs (which is slightly below the lowest daily flow in the past 30 years), the entire river will be raised by 4.8° (Permit hearing, pp. 763, 786, 2259); this low a flow occurs less than 0.5% of the time (id., p. 786). Virtually all the necessary mixing will occur within 600' downstream of the discharge pipe (id., p. 783), and most of it within 40' (id., pp. 2236-37). As for the absolute 90° standard, temperature records at Davenport, 22 miles downstream and said to reflect Quad-Cities temperatures, reveal temperatures as high as 85° on only four days in ten years, or 0.1% of the time (id., pp. 858-63), so that a 4° rise at the edge of the zone, the companies expect, will almost always be allowable (id., p. 824). Moreover, within the mixing zone itself, the companies say, most of the mixing will occur before the discharge reaches the surface, so that temperatures near the surface will not be raised more than four or five degrees anywhere on the river even under the worst conditions (id., pp. 784-85).

Edison and Iowa-Illinois thus argue that with their diffuser they will avoid the extreme river effects pictured by Walton League witnesses and comply with the existing standard. They further argue, as will be spelled out below, that in doing so they will cause no significant adverse effects on the river, and that, since the diffuser warms the whole river 4° at low water at the edge of the zone, they could not meet the proposed federal standard (86°, when normal temperatures reach 85°), or, of course, the proposed 5° effluent standard, without installing costly cooling ponds or cooling towers (Permit hearing, p. 825).

The federal position is, as the federal agency has also argued as to the Ohio River and as to Lake Michigan (## R 71-12, R 70-2), that the present standard is inadequate to protect aquatic life against temperature extremes during various seasons of the year. Monthly maximum temperatures, it is argued, are necessary

in order to avoid temperatures (which may be less than 5° above natural) that are high enough to endanger the viability of any species (Jan. 20. p. 93). The maxima proposed are based upon the biological needs of the fish actually present in each section of the river and on actual high temperatures occasionally encountered, on the ground that these are the temperatures to which the local fish are adapted (id., pp. 37, 83). A single 90° limit, a witness from the Bureau of Sport Fisheries and Wildlife explained, is inadequate, partly because there are much lower critical temperatures for fish reproduction during cooler times of the year (Mar. 3. pp. 145 et seq.). For a detailed discussion by federal fish biologist Donald Mount of the need for monthly maxima, see Mar. 3., pp. 94-130.

The utilities counter this argument with a comparison of fish life in Pool 14, to which Quad-Cities will discharge, with that in Pool 19, 170 miles downstream (Permit hearing, p. 967). During low-water conditions the temperature of Pool 14 will be raised by Quad-Cities, as presently planned, by 4°F., so that its temperature will on occasion be as much as 1.9° above that naturally occuring in Pool 19 downstream (id., p. 946). The biota of the two pools are said to be similar, with the same percentages of walleye, crappie, carp, and drum, although there are more catfish in Pool 19. Northern pike and yellow perch are said to be insignificant in Pool 14; walleye, sauger, and buffalo to be found in substantial numbers as far south as Pool 25 (300 miles below Pool 14), where temperatures are 2 1/2-5° above those in Pool 14 (id., pp. 949-55, 968). The catch per acre is said to be generally (not always, id., p. 979) better in the downstream Pool 19 (id., p. 949). Consequently the companies conclude, while conceding that species success at high temperatures elsewhere might be the result of adaptation (id., p. 1009), that the expected discharge from Quad-Cities will not result in any significant change either in species distribution or in total numbers of fish present (id., pp. 950, 982).

As in the Lake Michigan and Ohio River proceedings, ## R70-2 and R71-12, we find the federal argument in favor of monthly maxima highly persuasive, for the reasons given. If we were dealing with a small fraction of the river volume, we might be content with a limit of 5° above natural temperatures at the edge of a mixing zone, anticipating that further dilution would rapidly reduce temperatures in the river as a whole to near normal levels. But the Quad-Cities evidence makes plain that that is not what is at stake here. At low flow this single plant will utilize one-fifth to one-fourth of the river for cooling purposes, and after complete mixing the entire volume of the river below the plant will be raised four to five degrees above intake temperatures. Complete mixing will be achieved 600' downstream, but the temperature reached at the edge of this zone will persist for a considerable

distance downstream, since there is no additional water for further dilution. Elevated temperatures across the entire river will therefore remain until relatively slow processes such as evaporation dissipate the excess heat to the atmosphere. Edison's witnesses could not say how far downstream temperatures would remain above normal (Permit hearing, 840); an Izaak Walton League witness, extrapolating from the experience of the upstream Genoa plant, estimated that recovery would take ten miles (Feb. 24, pp. 81, 88); a federal witness quoted a Commonwealth Edison study showing that two and a half miles would be required (Apr. 23, p. 77); Edison itself in oral argument June 21 estimated that at low water a 3° rise over natural temperatures would persist for twelve miles.

The utilities argue that no significant harm will be done if the entire river is occasionally raised four or five degrees, because the same species thrive at higher temperatures 170 or 300 miles downstream. The utilities conceded that this might be due to adaptation, so that increase in temperature in Pool 14 might impose a stress on the population there, which is used to cooler water. Acclimation, as a federal fish biologist testified, can alter the lethal temperature (Permit hearing, p. 1354). We could not with equanimity comtemplate making the river warmer for significant periods at Quad-Cities than it is many miles below Keokuk, as admittedly will be the case at low water at Quad-Cities (Permit hearing, p. 886). To move this section of the river 170 miles south, in effect, would be a substantial alteration in natural conditions. Though similar biota may be able to thrive at both latitudes under appropriate circumstances, we think the threatened deviation from normal sufficiently great to create a risk to the existing population that is greater than should be taken. Moreover, the biota are not entirely the same in the two pools. The Illinois Department of Conservation has identified 13 fish species in Pool 14 not present in Pool 19 (Permit hearing, p. 2069). The blue sucker, grass pickerel and rainbow trout (an introduced species, id., p. 2106) are "sporadic" in Pool 14 and "any ecological change could very well eliminate these three species entirely from Pool 14" (id., p. 2072). Rainbow and carpsucker are at the southern end of their range, and yellow perch and northern pike, found in small numbers in Pool 14, are close to their marginal temperatures although they also occur further south; a 4° rise over a significant time period might interfere with pike or perch reproduction by causing premature spawning when food is unavailable for the young fish (id., pp. 2089-2101). Further, a Wisocnsin state fish expert testified that temperatures of 85° to 95° can be injurious to walleye spawning (id., p. 1967) and that a disease called myxbolus is likely to attack bluegills, white bass, and black crappies when temperatures reach 85° for a few days during spawning season (id., p. 1977). While the evidence falls short of conclusive proof that serious harm could necessarily result if the present standard were retained, we think no such showing is required. The day is past when contamination of the environment will be allowed until gross injury occurs; we think it important to avoid substantial and unnecessary risks of

harm, and therefore agree that monthly maxima should be adopted.

However, Edison has submitted additional temperature data compiled by Dr. H. D. Tomlinson of Ryckman, Edgerley, Tomlinson and Associates which indicate that the originally proposed federal maxima did not truly reflect the actual temperature experience of the river. Using Dr. Tomlinson's data as a guide the June and September maxima for an intermediate sector between the Iowa Border and the Alton Lock and Dam have been raised one degree above the maxima specified for the Zone between the Wisconsin and Iowa Border. The maxima for July and August for the intermediate sector north of Alton have been increased two degrees. We believe that these slight modifications, based on more complete information than was available at the time of last winter's St. Louis meetings, more accurately reflect the existing natural conditions to which the biota are actually exposed than do the original federal proposals, for the following reasons:

The Mississippi River temperature standard as proposed on June 28 provided for an 86° F. maximum in July and August with an "excursion" provision of 8°F. for up to 5 1/2 days in a year. An examination of daily temperature data recently received for the 27-year period from 1944-1970 as recorded at the Alton, Illinois water treatment plant revealed 21 periods totalling 137 days of temperatures at 86°F. or higher.

The intent of the temperature regulations is to determine the "natural" highs by month and to permit, in general, 5°F. above these highs, except when the resulting temperature would adversely affect aquatic life. The standard is then set to not permit the full 5°F. envelope to be used if damage will occur.

Obviously it is then of critical importance to know the "natural" high temperatures. The data analysis revealed that 88°F. in July and August and 86°F. in June and September were more realistic "natural highs" at Alton (the southern and warmest portion of its zone).

It is clear that what is to be feared is the warming of the river over a biologically significant period of time. An expert witness favoring the federal proposal testified that a 4° rise above natural conditions for as much as a week on rare occasions would not injure even the sensitive northern pike (Permit hearing, p. 2114). No one testified to the contrary,

and a federal spokesman suggested that provision might reasonably be made to allow the maxima to be exceeded for brief periods (March 3, pp. 221). We have so provided, by analogy to the existing provisions that require water quality standards generally to be met except during conditions of lowest flow. We believe on the present record that ample protection will be afforded during these short periods by requiring adherence to the 5°-above natural limitation and by providing that the maxima themselves never be exceeded by more than 3°.

It is not without importance that this provision will very likely result in the saving of something like $40,000,000 at the Quad-Cities plant alone without creating any significant additional risk to the river. The utilities believe their diffuser pipe will enable them to meet the 5° limit at all times, and the monthly maxima except during rare occasions when extremely low flows coincide with extremely high natural temperatures, measuring the 600' mixing zone from the center of the pipe. To require the installation of alternative cooling facilities to be used less than 1% of the time, we believe, would not under the circumstances be warranted.

We add that our initial fears that the wide diffuser pipe might not leave a sufficient zone of passage for organisms to travel up and down river (Permit hearing, pp. 1234-39) have been allayed by evidence showing that the jets of warm water from the diffuser (5° and more above natural temperatures) will occupy far less than 25% of the cross-section of the stream. The brief of the Attorney General in the Quad-Cities case objects to the new regulation on the ground that it will not assure a zone of passage that is at natural water temperature. But our conception of the zone of passage is that it limits the shape of a mixing zone so that not too much of the river's cross-section exceeds the water quality standard; having set a standard that we think will protect aquatic life if achieved in the river as a whole, we do not believe a still tighter standard is needed for the zone of passage.

The monthly maxima apply to the main river and not to shallow backwaters where natural temperatures are likely to exceed the prescribed limits on sunny days. The 5°-above-natural limit applies everywhere, and to meet the maxima in the main river should assure that temperatures in shallow areas, which are naturally higher, are not excessive.

The exact size of the mixing zone is not a matter for scientific determination. There is nothing magic about 600'; like the 21 (or 18)-year voting age, it is a number selected to draw a rough but clear line to separate points on a continuum. Perhaps 300' or 1000'

would be equally acceptable. What is clear is that a small portion of the river may safely be warmed and a large portion may not, and the exact location of the dividing line is obviously less important than that a clear line be drawn somewhere for the guidance of government agencies and of river users. In another proceeding we have proposed, state-wide, to establish a minimum zone of passage in addition to the 600' limitation on mixing zones (R71-14); on the wide Mississippi , the 600' zone itself serves in many cases to assure a zone of passage. As for the federally proposed monthly maxima, it is clear that expanding the mixing zone to 1000' or even more downstream of a diffuser pipe such as planned for Quad-Cities would make little difference; as the principal mixing occurs within 600', there is little dilution water downstream, and the 4° rise over natural at low flow will persist for much farther down the river. Moreover, the federal agency has made clear that 600' is the largest zone acceptable on the Mississippi (Permit hearing, pp. 1234-39), and we think that it is a reasonable size.

The Izaak Walton League proposal would do away with mixing zones altogether by providing that effluents discharged to the river themselves not exceed prescribed monthly maxima, and that effluents in no case be more than 5° above natural temperature. This concept has the support of both the state Department of Conservation (Apr. 23, p. 85) and the state Environmental Protection Agency (ex.10). Ideally, of course, nothing would be discharged to any stream that is of poorer quality than the stream quality standard itself; no portion of the river would be allowed to exceed the standard. Even the proponents of the effluent standard, however, recognize that the addition of very small volumes of high-temperature water to a big river have no significant effect and that the costs of prohibiting such discharges would far exceed the observable benefits. Thus a Walton League witness acknowledged that the proposal was not meant to apply to discharges from motorboats (Feb. 24, p. 19-20); and the federal agency, which never took a firm stand on the desirability of mixing zones (except to say 600' would be the maximum acceptable), proposed that discharges from sewage treatment plants, water purification plants, vessels, closed-system blowdown, and other small sources be exempted from the standard (Permit hearing, pp. 1234-39).

The mixing zone is a simple means of protecting the river as a whole while avoiding the imposition of substantial cooling costs on smaller installations that affect an insignificant fraction of the river. Apart from the utilities constructing the mammoth Quad-Cities plant, none of the industrial users of Mississippi River water objected to the adoption of the federal standard with a 600' mixing zone, apparently because this affords them ample room in which the river can assimilate their discharges. And the total area of the river affected by these sources, if that is true, is insignificant, Principal existing sources are the following power plants: CILCO, 216 mw at Grand Tower; Iowa-Illinois, 99 mw at Moline; Union Electric, 500 mw at Venice and 300 mw at Wood River (Mar. 3, p. 195). Illinois Power testified against the effluent standards but said it could meet both the monthly maxima and the 5° rise limitation at the edge of a 600' zone.

The impact of an effluent standard upon still smaller contributors of heat was graphically demonstrated. Several industrial

water users testified without contradiction that in order to meet th proposed effluent standards even wet cooling towers would not suffic since wet bulb temperatures sometimes exceed the proposed limits; refrigeration would be required (Apr. 23, pp. 116-27 (Shell Oil), 149-59 (Corn Products), 159-62 (American Oil), 64-77 (Olin), 127-48 (Illinois Power)). The evidence is clear that most of these discharges, at least, will disappear within 600 feet. This evidence shows the desirability of mixing zones in order to avoid the expenditure of millions of dollars to escape perfectly trivial effects on the river.

Effluent standards of course have the advantage of easy enforcement; one simply measures the temperature of the discharge, and, to determine the increase, also of the intake. Dipping thermometers into the stream 600 feet around a discharge point is more cumbersome and less accurate. But it is perfectly acceptable, as was suggested by the federal EPA, that compliance with the stream quality standards be generally determined by theoretical computations based on relative temperatures and volumes of effluent and of receiving stream (Jan. 20, p. 75), subject to refutation by actual measurement.

As was brought out in cross-examination by the Quad-Cities utilities, the new standard, like the old, does not afford complete protection for the river because it does not limit the number of mixing zones that may exist (Permit hearing, p. 1274). It is therefore still possible for a substantial portion of the river to be heated beyond the standard by a proliferation of heat sources each affecting only a very small area. In order to fill this gap in the regulation we have proposed, in another proceeding (#R 71-14), to limit the total use of cooling water within any several mile stretch of any stream. Pending decision as to that additional proposal, we think the standard we adopt today provides a reasonable first step, and a significant improvement on the earlier standard, toward full stream protection.

The availability of alternative cooling devices such as ponds, towers, or spray canals to meet the new standard is not in issue; for a full discussion of alternatives see the Board's opinion in #R 70-2, Thermal Standards, Lake Michigan. The companies' amended application considers such alternatives in some detail. We believe that, where required by the new standard, the costs and environmental disadvantages (see opinion in #R 70-2) of ponds, towers or spray canals are justified in order to avoid a substantial alterat in the temperature of a significant portion of the stream.

As on Lake Michigan, we also require that the effects of new large sources be studied and that correction be made if significant harm is shown. The present standards are based on curren knowledge, which is incomplete; we must review them in the light of future learning.

We have included in the regulation a provision allowing for re-examination of any permit if future development shows a need to reallocate the heat capacity of the stream. The ability of the stream to absorb heat without harm is a limited and valauble resource, and we cannot simply resign it entirely to the first comer. To deny permits today on the basis that future development might require reallocation of the permittee's share would leave the resource unused in the interim. We think it preferable to give fair warning that the grant of a permit is not a deed of irrevocable rights as against future prospective users.

ORDER

I. Rule 1.05 c of Rules and Regulation SWB-12, Rule 1.05 (4) and 2.05 (3) of SWB-13 are hereby amended to read as follows:

All sources of heated effluents shall meet the following restrictions outside of a mixing zone which shall extend no farther in any direction from an effluent discharge than 600 feet. The mixing zone shall include no more than one-fourth of the cross sectional area of the river nor shall it, at any time, extend to more than one-half of the surface of any river sector.

A. There shall be no abnormal temperature changes that may affect aquatic life unless caused by natural conditions.

B. The normal daily and seasonal temperature fluctuations that existed before the addition of heat due to other than natural causes shall be maintained.

C. The maximum temperature rise at any time or place above natural temperatures shall not exceed 5°F.

D. In addition, the water temperature at representative locations in the main river shall not exceed the maximum limits in the following table during more than one percent of the hours in the 12-month period ending with any month. Moreover, at no time shall the water temperature at such locations exceed the maximum limits in the following table by more than 3°F.

	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
Mississippi River (Wisc. Border to Iowa Border) (°F)	45°	45°	57°	68°	78°	85°	86°	86°	85°	75°	65°	52°
Mississippi River (Iowa Border to Alton Lock and Dam) (°F)	45°	45°	57°	68°	78°	86°	88°	88°	86°	75°	65°	52°
Mississippi River (So. of Alton Lock & Dam) (°F)	50"	50°	60°	70°	80°	87°	89°	89°	87°	78°	70°	57°

Main river temperatures are temperatures of those portions of the river essentially similar to and following the same thermal regime as the temperatures of the main flow of the river.

II. A. The owner or operator of a source of heated effluent which discharges 0.5 billion British thermal units per hour or more shall demonstrate in a hearing before this Board not less than 5 or more than 6 years after the effective date of these regulations or, in the case of new sources, after the commencement of operation, that discharges from that source have not caused and cannot be reasonably expected to cause significant ecological damage to the River. If such proof is not made to the satisfaction of the Board, appropriate corrective measures shall be ordered to be taken within a reasonable time as determined by the Board.

B. Permits for heated effluent discharges, whether issued by the Board or the Environmental Protection Agency, shall be subject to revision in the event that reasonable future development creates a need for reallocation of the assimilative capacity of the river as defined in the regulation above.

C. The owner or operator of source of heated effluent shall maintain such records and conduct such studies as may be required by the Environmental Protection Agency or in any permit granted under the Environmental Protection Act.

D. Appropriate corrective measures will be required if, upon complaint filed in accordance with Board rules, it is found at any time that any heated effluent causes significant ecological damage to the River.

III. Rule 1.07 (4) of SWB-12 and Rule 3.01 (4) of SWB-13 are hereby repealed.