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New York State Department of Environmental Conservation

Division of Fish and Wildlife Technical Guidance 2

Issuing Authority: Tony Wilkinson Director, Division of Fish and Wildlife Signature:	**Title:** Velocity Cap Efficacy Estimation for use in Best Technology Available Determinations
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*** N O T I C E ***

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I. Summary: This document describes the procedures for allowing velocity cap efficacies to be included as a component of Best Technology Available ("BTA") for the purposes of meeting the requirements of 6 NYCRR Part 704.5. This guidance was developed by the Bureau of Ecosystem Health in the Division of Fish and Wildlife.

II. Policy: It is the policy of the Department that, where applicable and as described in this guidance, SPDES permits issued for cooling water intake structures (CWISs) in New York State may include site-specific efficacy estimates for existing technologies, including velocity caps, that are documented to reduce the impingement mortality of fish. The final inclusion of site-specific velocity cap efficacy estimates as part of a BTA decision for a facility is at the discretion of the Department when making a BTA determination following procedures set forth in Department Policy CP-52 (July 10, 2011).

III. Background: Industrial facilities operating a CWIS in connection with a point source thermal discharge must minimize the adverse environmental impact caused by the CWIS (6 NYCRR Part 704.5). DEC Policy CP-52, which implements 6 NYCRR Part 704.5, defines adverse environmental impact as the number of fish and shellfish killed or injured through entrainment and impingement mortality by the operation of CWISs. Impingement mortality is the death of all life stages of fish and shellfish as a result of being entrapped on the outer part of a CWIS or against a screening device during periods of water withdrawal. Entrainment is the incorporation of all life stages of fish and shellfish with intake water flow entering and passing through a CWIS and into a cooling water system (*see*, Department Policy CP-52).

The EPA designated an offshore intake fitted with a velocity cap as a predetermined technology to meet the impingement performance requirements of the Clean Water Act Section 316(b) 2014 Phase II Rule for Existing facilities (*i.e.*, an annual reduction in impingement mortality of 76 percent or greater) (*see*, 40 CFR § 125.94(c)(4)). Unfortunately, no site-specific data exists that can verify that offshore intakes fitted with a velocity cap at New York facilities are sufficient to meet the performance goals of Commissioner Policy CP-52 for impingement mortality.

The ability of juvenile and adult fish to behaviorally avoid being entrapped by a CWIS is highly dependent on the fish's ability to detect and respond to water current direction (Pavlov 1969). Vertically oriented currents are not easily detected by fish so they are not able to behaviorally respond to vertically oriented displacements of water into a CWIS (U.S. EPA 2011, Liao 2007, Mussalli *et al.* 1980). Since fish lack the ability to detect a vertical flow of water entering a CWIS, they would not be able to behaviorally avoid being entrapped by the intake structure and would ultimately be impinged on trash screens. Fish are very good at detecting horizontal flows and most fish species tend to respond to horizontal flows by swimming into the current (Liao 2007, Helvey and Dorn 1987). Depending on the fish's ability to swim away from the horizontal current field, this behavioral response could prevent fish from being entrapped by a CWIS if the water is flowing in a horizontal direction (Helvey and Dorn 1987).

Most offshore intakes are oriented with the opening of the intake pointing towards the surface of the water body. This orientation of the intake results in a vertical displacement, or flow, of water into the intake. The velocity cap is basically a horizontal cover that will redirect this vertical intake flow to a horizontal flow (*see*, Figure 6; Radin and Shashidhara 1986 *at* p. 203). The use of velocity caps on offshore CWISs have been in practice since the late 1950s when it was determined that fish cannot effectively sense a vertical displacement of water (MBC 2007, Turnpenny and Taylor 2000, Johnson *et al.* 1980, Mussalli e*t al.* 1980, Thomas *et al.* 1980). The first velocity cap was installed on the El Segundo Steam Electric Station in southern California where it was estimated that the entrapment of fish in the offshore intake structure was reduced by 80-90 percent (Mussalli *et al.* 1980). Several facilities operating in California, England, and New York have included velocity caps in the design of offshore intake structures.

In New York State, seven steam electric generating units have offshore CWISs equipped with velocity caps. These seven units include: Nine Mile Point Nuclear Power Plant Units 1 and 2; Oswego Generating Station Units 1 and 2; Somerset, Fitzpatrick Nuclear Power Plant; and the R.E. Ginna Nuclear Power Plant. Velocity caps were included in the original design of the CWIS for these facilities in part due to their demonstrated efficacy in reducing the entrapment of fish at facilities in California and in England. However, as a result of including the velocity caps in the original design of these facilities, no site-specific velocity cap efficacy studies were conducted to determine the reduction in entrapment of Lake Ontario fish species.

Commissioner Policy CP-52 requires a demonstrated efficacy in reducing impingement mortality commensurate to that achievable with a closed-cycle cooling system. For many technologies, the efficacy of the technology in reducing impingement mortality can be studied after the selected technology is installed and operational (*e.g.*, cylindrical wedgewire screens, modified ristroph traveling screens, seasonally deployed barrier nets). However, post installation efficacy determination is technically challenging with the velocity caps that are being used in New York State. For example, it is not possible to determine a baseline impingement by removing the velocity cap to compare the resulting impingement to that resulting from when the velocity cap is installed.

Given the requirement for these facilities to demonstrate the site-specific efficacy of BTA technologies, an estimate of the efficacy of pre-existing velocity caps needs to be accounted for. One option to handle this technical challenge would be to assume that the velocity caps have no effect on reducing impingement. This option would not be reasonable given the consistently documented efficacy of velocity caps employed at several facilities. It would be more reasonable to determine an average efficacy from the studies previously conducted in California and England and apply that efficacy to the facilities in New York State that operate an offshore intake equipped with a velocity cap (*see*, Table 1).

Table 1 summarizes the efficacy in the use of velocity caps that have been studied at several California facilities and at two Great Britain facilities.

Table 1: Efficacies reported for several facilities operating an offshore intake equipped with a velocity cap.

Facility	Efficacy	Source
SONGS, CA	77%	Johnson *et al.* 1980
El Segundo, CA	85%	Mussalli *et al.* 1980
Huntington Beach, CA	82%	Thomas *et al.* 1980
Sizewell B, England	50%	Turnpenny *et al*. 2000
Scattergood 2006, CA	99%	MBC 2007
Ormund Beach, CA	74%	Thomas *et al.* 1980
Dungeness B, England	63%	Spencer & Fleming 1987
Average Efficacy: 76%		

For several of the facilities (*e.g.*, SONGS, Scattergood, Ormond Beach, Huntington Beach), it was possible to reverse the flow of water through the cooling water system to allow for the withdrawal of water through the discharge pipe which was not fitted with a velocity cap. The two facilities in England operated a second unit where the offshore intake was not equipped with a velocity cap. This allows for a "side-by-side" comparison of the impingement rates.

An additional complication in determining the efficacy of a velocity cap for the seven generating units in New York is that the efficacy of a velocity cap is potentially influenced by the behavior (*i.e.*, pelagic, demersal, or benthic) of the species that are found near the intake (Turnpenny 1988, Helvey and Dorn 1987, Helvey 1985). Based on the data provided in reports for studies conducted at the Scattergood and SONGS facilities located on the California coast, pelagic species appear to benefit the greatest amount from the use of a velocity cap (MBC 2007, Johnson *et al.* 1980) (*see*, Table 2).

Table 2: Behavior dependent efficacies of offshore intake equipped with a velocity cap.

	Estimated Efficacy of Velocity Cap	
Behavior	**Scattergood (2007)**	**SONGS (1980)**
Pelagic	99.5%	84.9%
Demersal or Benthic	57.3%	57.2%

Pelagic fish tend to numerically dominate impingement but they generally represent substantially fewer species than the demersal/benthic fish community that is impinged. Based on the results of these two studies, velocity caps appear to disproportionately benefit pelagic species, therefore it is important to know which species are potentially entrapped by a site specific CWIS and what their behavior is before deciding the effectiveness of the velocity cap in reducing impingement.

IV. Responsibility: The Department's Division of Fish and Wildlife ("DFW") has the primary responsibility to ensure that the methods contained in this guidance are adhered to by a SPDES permittee desiring the Department to consider velocity cap efficacy at a permitted industrial facility.

V. Procedure

General: Definitions, Applicability, and Limitations

1. Definitions

The following definitions will be used for this guidance:

- *Adverse environmental impact*: the fish and shellfish killed or injured through entrainment and impingement by the operation of cooling water intake structures.

The “adverse environmental impact” that must be minimized by the BTA standard of 6 NYCRR §704.5 relates only to aquatic resources (Commissioner Policy CP-#52).

- *Best Technology Available (“BTA”)*: technology based standard established under CWA Section 316(b), 40 C.F.R. Part 125, subpart I; 40 C.F.R. Part 125.90(b); and 40 C.F.R. Part 125, subpart N and 6 NYCRR Part 704.5 as the most effective technology, process, or operational method for minimizing adverse environmental impact from a CWIS (Commissioner Policy CP-#52).

- *Calculation baseline*: an estimate of impingement mortality and entrainment that would occur at a cooling water intake structure assuming that: the cooling water system has been designed as a once-through system; the opening of the cooling water intake structure is located at, and the face of the standard 3/8-inch mesh conventional traveling screen is oriented parallel to, the shoreline near the surface of the source waterbody and is operated at the full rated capacity 24 hours a day, 365 days a year (Commissioner Policy CP-#52).

- *Cooling water*: the water used for contact or non-contact cooling, including water used for equipment cooling, evaporative cooling tower makeup, and dilution of effluent heat content. The intended use of the cooling water is to absorb waste heat rejected from the process or processes used, or from auxiliary operations on the facility's premises [6 NYCRR § 700.1(a)(11)].

- *Cooling water intake structure (CWIS)*: the total physical structure and any associated constructed waterways used to withdraw cooling water from waters of New York State. The cooling water intake structure extends from the point at which water is withdrawn from the waters of the State up to, and including the intake pumps [6 NYCRR § 700.1(a)(12)].

- *Entrainment:* the incorporation of all life stages of fish with intake water flow entering and passing through a cooling water intake structure and into a cooling water system. The Department assumes that entrainment results in 100 percent mortality of the entrained organisms unless a lesser mortality is demonstrated to Department staff based on the results of Department approved, site-specific entrainment survival studies (Commissioner Policy CP-#52).

- *Ichthyoplankton*: refers to the early life stages of fish including eggs, yolk-sac larvae, and post yolk-sac larvae.

- *Impingement mortality*: the death of all life stages of fish as a result of being entrapped on the outer part of a cooling water intake structure or against a screening device during periods of water withdrawal (Commissioner Policy CP-#52).

- *Once-through, non-contact cooling water system*: a system designed to withdraw water from a natural or other water source, use it at the facility to support contact

and/or noncontact cooling uses, and then discharge it to a waterbody without recirculation (Commissioner Policy CP-#52).

2. Applicability and Limitations

a. General Application of Velocity Cap Efficacy for Reducing Impingement

Given that there are several documented instances where velocity caps have substantially reduced the impingement of fish, some impingement reduction allowance can be allowed for New York State facilities that operate an offshore CWIS fitted with a velocity cap. This can be accomplished by applying the average reduction from the efficacies reported in Table 1 accounting for the differences based on behavior presented in Table 2. This gives an average of 76% reduction +/- 14.7% (efficacy range: 61% to 90%). An average of 76% alone would not meet the performance goals of CP-52 and additional measures would be required. However, a cooling water intake system consisting of an offshore intake equipped with a velocity cap, modified ristroph-type traveling screens, and a fish handling and return system would reduce impingement mortality further (Fletcher 1990). In addition, since a large proportion of fish impinged on Lake Ontario are alewives, the addition of a sonic deterrent system on the offshore intake would provide additional reductions in impingement mortality (Ross and Dunning 1996).

In summary, Table 3 presents a suite of technologies that are likely to provide impingement reduction levels to potentially meet the performance goals of CP-52:

Table 3: Estimated efficacies to be applied to New York facilities operating an offshore intake equipped with a velocity cap, sonic deterrent (if applicable), and ristroph screens with a fish return system.

Technology	Efficacy All species	Benthic Species Dominate
Velocity cap	76%	57%
Sonic Deterrent (alewives only)[1]	84%	84%
Ristroph Screens[2]	80%	80%
	Cumulative Efficacy:	
Minimum (no sonic deterrent)	95%	91%
Maximum	99%	98%

The “Benthic Species Dominate” option is provided if a facility impinges a disproportionately high (*e.g.*, ≥75%) percentage of benthic/demersal species. In addition, final efficacies of modified ristroph-type traveling screens and sonic deterrents must be determined with a site-specific verification monitoring program after installation of all BTA technologies. This will be determined on a case-by-case Best Professional Judgment basis.

[1] Ross and Dunning 1996.
[2] Fletcher 1990.

If the permittee desires to demonstrate compliance with 6 NYCRR Part 704.5 solely with the use of a velocity cap or requests to use an efficacy greater than depicted in Table 3, the permittee may be required to conduct a site-specific velocity cap verification study as a requirement of their SPDES permit. Such a study would require DFW staff review and approval prior to undertaking such a study (either before a BTA determination is made or as part of a Verification Monitoring Study). However, the Department is under no obligation to accept the results of such a study given the difficulties and uncertainties in estimating efficacy at an existing facility operating an existing velocity cap.

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