

**Supplemental Information on  
Methods for Estimating Costs of Cooling Water Intake Structure  
Technologies**

Background Information for Potential Small Entity Representatives  
On EPA's Rulemaking Project:

“Proposed Regulations to Establish  
Requirements for Cooling Water Intake Structures  
at Section 316(b) Phase III Facilities”

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U.S. Environmental Protection Agency  
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## Example 1. Facility Requires Upgrade to Add Fish Handling and/or Return System to Existing Traveling Screen

Facility A is a coal-fired steam electric facility located on a freshwater river in Tennessee. The facility has a design intake flow of 25 million gallons per day (mgd) and an existing traveling screen system with 3/8 inch mesh (coarse mesh). To comply with the preliminary Phase III regulatory requirements, Example Facility A would be required to add a fish handling and/or return system to the existing traveling screen.

### Step 1: Determine the total design intake flow for the facility.

The records indicate that the design intake flow for Facility A is 25 mgd. In the proposed Phase II regulations, EPA defined design intake flow as “the value assigned during the facility’s design to the total volume withdrawn from the source waterbody over a specific time period.” Each facility should have the design intake flow value available in their records or it can be estimated based on the size of the intake pumps. The design intake flow must be in the units “gallons per minute (gpm)” for use with the equations in Steps 2 and 3. Therefore, to convert the design intake flow from mgd to gpm use the following equation:

$$X \text{ (gpm)} = X \text{ (mgd)} \times \frac{1,000,000 \text{ gallons}}{1 \text{ million gallons}} \times \frac{1 \text{ day}}{24 \text{ hours}} \times \frac{1 \text{ hour}}{60 \text{ minutes}}$$

Convert the 25 mgd to gpm as follows:

$$X \text{ (gpm)} = 25 \text{ (mgd)} \times \frac{1,000,000 \text{ gallons}}{1 \text{ million gallons}} \times \frac{1 \text{ day}}{24 \text{ hours}} \times \frac{1 \text{ hour}}{60 \text{ minutes}}$$

$$X = 17,361 \text{ gpm}$$

### Step 2: Select the appropriate equation from Table 1 (see below) to use in determining the “Initial Capital Costs.”

Using the value for the total design intake flow (in gpm) determined in Step 1, you can select the appropriate equation from Table 1 to use in determining the “Initial Capital Costs.” Since the example facility has a design intake flow of 17,361 gpm, the appropriate equation to use from Table 1 is Equation C because it corresponds to flows that range between 6,000 and 30,000 gpm.

$$Y = (-9E^{-7}X^2 + 1.5046X + 29971) \quad [\text{See Eqn C, Table 1}]$$

Where X is the total design intake flow (in gpm), and  
Y is the Initial Capital Costs (in U.S. dollars)

**Step 3: Calculate the “Initial Capital Costs.”**

Using the design intake flow determined in Step 1 and the equation identified in Step 2 above, you can calculate the Initial Capital Costs using Equation C from Table 1 as follows:

$$Y = \left( -9E^7(17,361)^2 + 1.5046(17,361) + 29,971 \right)$$

$$Y = \$55,821$$

**Step 4: Identify the appropriate construction factor (CF) from Table 2 (see below) based on the compliance requirements.**

Since the facility is a non-nuclear facility that requires the addition of a fish handling and/or return system, the construction factor (CF) from Table 2 would be zero (0).

**Step 5: Identify the appropriate state-specific capital cost factor (SF) from Table 3 (see below).**

Since the facility is located in Tennessee, the state-specific capital cost factor (SF) is 0.803 from Table 3.

**Step 6: Escalate the “initial capital costs” using the factors to Calculate the Total Estimated Capital Costs (TECC).**

To escalate the “initial capital costs” calculated in Step 3 to the total estimated capital costs (TECC) use the following equation:

$$TECC = (Initial\ Capital\ Cost) \times (1 + RF + CF + Allowance) \times (SF)$$

Where TECC is the total estimated capital costs (in U.S. dollars),  
RF is a retrofit factor of 30 percent,  
CF is a construction factor (from Table 2, see Step 4),  
Allowance is 5 percent, and  
SF is a state-specific factor (from Table 3, see Step 5).

Entering the cost factors (CF and SF) identified in Steps 3 and 4, adding a retrofit factor of 30 percent, and an allowance of 5 percent to the overall capital costs to account for retrofitting an existing intake structure, you can calculate the total costs as follows:

$$TECC = (\$55,821) \times (1 + 0.30 + 0 + 0.05) \times (0.803)$$

$$TECC = \$60,512$$

**Step 7: Select the appropriate equation from Table 4 to use in determining the “Yearly Operation and Maintenance Costs.”**

Using the value for the total design intake flow (in gpm) determined in Step 1 you can select the appropriate equation from Table 4 to use in determining the “Yearly Operation and Maintenance Costs.” Since the example facility has a design intake flow of 17,361 gpm, the appropriate equation to use from Table 4 is Equation C because it corresponds to flows that range between 6,000 and 30,000 gpm.

$$Y = (-8E^{-8}X^2 + 0.0668X + 1387.1) \quad [\text{See Eqn C, Table 4}]$$

Where X is the total design intake flow (in gpm), and  
Y is the Initial Capital Costs (in U.S. dollars)

**Step 8: Calculate the Yearly Operation and Maintenance Costs.**

Using the design intake flow determined in Step 1 and the equation identified in Step 7 above, you can calculate the yearly Operation and Maintenance Costs using Equation C from Table 4 as follows:

$$Y = (-8E^{-8}(17,361)^2 + 0.0668(17,361) + 1387.1)$$

$$Y = \$25,223$$

**Example 2. Facility Requires Upgrade to Add Fine Mesh Screens to Existing Traveling Screens and Fish Handling and/or Return System**

Facility B is a manufacturer located on an estuary in Massachusetts. The facility has a design intake flow of 200 million gallons per day (mgd) and an existing traveling screen with a fish handling and/or return system. To comply with preliminary Phase III requirements, Example Facility B would be required to add fine mesh screens to reduce entrainment.

**Step 1: Determine the total design intake flow for the facility.**

The records indicate that the design intake flow for Facility B is 200 mgd. In the proposed Phase II regulations, EPA defined design intake flow as “the value assigned during the facility’s design to the total volume withdrawn from the source waterbody over a specific time period.” Each facility should have the design intake flow value available in their records or it can be estimated based on the size of the intake pumps. The design intake flow must be in the units “gallons per minute (gpm)” for use with the equations in Steps 2 and 3. Therefore, to convert the design intake flow from mgd to gpm use the following equation:

$$X \text{ (gpm)} = X \text{ (mgd)} \times \frac{1,000,000 \text{ gallons}}{1 \text{ million gallons}} \times \frac{1 \text{ day}}{24 \text{ hours}} \times \frac{1 \text{ hour}}{60 \text{ minutes}}$$

Convert the 200 mgd to gpm as follows:

$$X \text{ (gpm)} = 200 \text{ (mgd)} \times \frac{1,000,000 \text{ gallons}}{1 \text{ million gallons}} \times \frac{1 \text{ day}}{24 \text{ hours}} \times \frac{1 \text{ hour}}{60 \text{ minutes}}$$

$$X = 138,889 \text{ gpm}$$

**Step 2: Select the appropriate equation from Table 1 (see below) to use in determining the “Initial Capital Costs.”**

Using the value for the total design intake flow (in gpm) determined in Step 1, you can select the appropriate equation from Table 1 to use in determining the “Initial Capital Costs.” Since the example facility has a design intake flow of 138,889 gpm, the appropriate equation to use from Table 1 is Equation H because it corresponds to flows that range between 60,000 and 225,000 gpm and the required technology upgrade.

$$Y = (5E^{-11} X^3 - 0.00002X^2 + 5.6762X + 81695) \text{ [See Eqn H, Table 1]}$$

Where X is the total design intake flow (in gpm), and  
Y is the Initial Capital Costs (in U.S. dollars)

**Step 3: Calculate the “Initial Capital Costs.”**

Using the design intake flow determined in Step 1 and the equation identified in Step 2 above, you can calculate the Initial Capital Costs using Equation H from Table 1 as follows:

$$Y = (5E^{-11}(138,889)^3 - 0.00002(138,889)^2 + 5.6762(138,889) + 81695)$$

$$Y = \$618,213$$

**Step 4: Identify the appropriate construction factor (CF) from Table 2 (see below) based on the compliance requirements.**

Since the facility is a non-nuclear facility that requires the addition of a fine mesh screens, the construction factor (CF) from Table 2 would be thirty percent (30%).

**Step 5: Identify the appropriate state-specific capital cost factor (SF) from Table 3 (see below).**

Since the facility is located in Massachusetts, the state-specific capital cost factor (SF) is 1.064 from Table 3.

**Step 6: Escalate the “initial capital costs” using the factors to Calculate the Total Estimated Capital Costs (TECC).**

To escalate the “initial capital costs” calculated in Step 3 to the total estimated capital costs (TECC) use the following equation:

$$TECC = (Initial\ Capital\ Cost) \times (1 + RF + CF + Allowance) \times (SF)$$

Where  
TECC is the total estimated capital costs (in U.S. dollars),  
RF is a retrofit factor of 30 percent,  
CF is a construction factor (from Table 2, see Step 4),  
Allowance is 5 percent, and  
SF is a state-specific factor (from Table 3, see Step 5).

Entering the cost factors (CF and SF) identified in Steps 3 and 4, adding a retrofit factor of 30 percent, and an allowance of 5 percent to the overall capital costs to account for retrofitting an existing intake structure, you can calculate the total costs as follows:

$$TECC = (\$618,213) \times (1 + 0.30 + 0.30 + 0.05) \times (1.064)$$

$$TECC = \$1,085,335$$

**Step 7: Select the appropriate equation from Table 4 to use in determining the “Yearly Operation and Maintenance Costs.”**

Using the value for the total design intake flow (in gpm) determined in Step 1 you can select the appropriate equation from Table 4 to use in determining the “Yearly Operation and Maintenance Costs.” Since the example facility has a design intake flow of 138,889 gpm, the appropriate equation to use from Table 4 is Equation H because it corresponds to flows that range between 60,000 and 225,000 gpm and the required technology upgrade.

$$Y = (4E^{-13}X^3 - 3E^{-7}X^2 + 0.1715X + 8472.1) \quad [\text{See Eqn H, Table 4}]$$

Where X is the total design intake flow (in gpm), and  
Y is the Initial Capital Costs (in U.S. dollars)

**Step 8: Calculate the Yearly Operation and Maintenance Costs.**

Using the design intake flow determined in Step 1 and the equation identified in Step 7 above, you can calculate the yearly Operation and Maintenance Costs using Equation H from Table 4 as follows:

$$Y = (4E^{-13}(138,889)^3 - 3E^{-7}(138,889)^2 + 0.1715(138,889) + 8472.1)$$

$$Y = \$27,576$$

**Example 3. Facility Requires Upgrade to Add Fine Mesh Screens and Fish Handling and/or Return System to Existing Traveling Screens System**

Facility C is a manufacturer located on one of the Great Lakes in Minnesota. The facility has a design intake flow of 3 million gallons per day (mgd) and an existing traveling screens system. To comply with the preliminary Phase III regulatory requirements, Example Facility C would be required to add fine mesh screens to reduce entrainment and fish handling and/or return system to reduce impingement mortality.

**Step 1: Determine the total design intake flow for the facility.**

The records indicate that the design intake flow for Facility C is 3 mgd. In the proposed Phase II regulations, EPA would define design intake flow as “the value assigned during the facility’s design to the total volume withdrawn from the source waterbody over a specific time period.” Each facility should have the design intake flow value available in their records or it can be estimated based on the size of the intake pumps. The design intake flow must be in the units “gallons per minute (gpm)” for use with the equations in Steps 2 and 3. Therefore, to convert the design intake flow from mgd to gpm use the following equation:

$$X \text{ (gpm)} = X \text{ (mgd)} \times \frac{1,000,000 \text{ gallons}}{1 \text{ million gallons}} \times \frac{1 \text{ day}}{24 \text{ hours}} \times \frac{1 \text{ hour}}{60 \text{ minutes}}$$

Convert the 3 mgd to gpm as follows:

$$X \text{ (gpm)} = 3 \text{ (mgd)} \times \frac{1,000,000 \text{ gallons}}{1 \text{ million gallons}} \times \frac{1 \text{ day}}{24 \text{ hours}} \times \frac{1 \text{ hour}}{60 \text{ minutes}}$$

$$X = 2,083 \text{ gpm}$$

**Step 2: Select the appropriate equation from Table 1 (see below) to use in determining the “Initial Capital Costs.”**

Using the value for the total design intake flow (in gpm) determined in Step 1, you can select the appropriate equation from Table 1 to use in determining the “Initial Capital Costs.” Since the example facility has a design intake flow of 2,083 gpm, the appropriate equation to use from Table 1 is Equation 1 because it corresponds to flows that range between 0 and 5,000 gpm and the required technology upgrade.

$$Y = (8E^{-9}X^3 - 0.0004X^2 + 15.03X + 33044) \quad [\text{See Eqn 1, Table 1}]$$

Where X is the total design intake flow (in gpm), and  
Y is the Initial Capital Costs (in U.S. dollars)



**Step 3: Calculate the “Initial Capital Costs.”**

Using the design intake flow determined in Step 1 and the equation identified in Step 2 above, you can calculate the Initial Capital Costs using Equation 1 from Table 1 as follows:

$$Y = (8E^{-9}(2083)^3 - 0.0004(2083)^2 + 15.03(2083) + 33044)$$

$$Y = \$62,688$$

**Step 4: Identify the appropriate construction factor (CF) from Table 2 (see below) based on the compliance requirements.**

Since the facility is a non-nuclear facility that requires the addition of a fine mesh screens and fish handling and/or return system, the construction factor (CF) from Table 2 would be fifteen percent (15%).

**Step 5: Identify the appropriate state-specific capital cost factor (SF) from Table 3 (see below).**

Since the facility is located in Minnesota, the state-specific capital cost factor (SF) is 1.046 from Table 3.

**Step 6: Escalate the “initial capital costs” using the factors to Calculate the Total Estimated Capital Costs (TECC).**

To escalate the “initial capital costs” calculated in Step 3 to the total estimated capital costs (TECC) use the following equation:

$$TECC = (Initial\ Capital\ Cost) \times (1 + RF + CF + Allowance) \times (SF)$$

Where TECC is the total estimated capital costs (in U.S. dollars),  
RF is a retrofit factor of 30 percent,  
CF is a construction factor (from Table 2, see Step 4),  
Allowance is 5 percent, and  
SF is a state-specific factor (from Table 3, see Step 5).

Entering the cost factors (CF and SF) identified in Steps 3 and 4, adding a retrofit factor of 30 percent, and an allowance of 5 percent to the overall capital costs to account for retrofitting an existing intake structure, you can calculate the total costs as follows:

$$TECC = (\$62,688) \times (1 + 0.30 + 0.15 + 0.05) \times (1.046)$$

$$TECC = \$98,358$$

**Step 7: Select the appropriate equation from Table 4 to use in determining the “Yearly Operation and Maintenance Costs.”**

Using the value for the total design intake flow (in gpm) determined in Step 1 you can select the appropriate equation from Table 4 to use in determining the “Yearly Operation and Maintenance Costs.” Since the example facility has a design intake flow of 2,083 gpm, the appropriate equation to use from Table 4 is Equation I because it corresponds to flows that range between 0 and 5,000 gpm and the required technology upgrade.

$$Y = (-8E^{-6}X^2 + 0.806X + 3646.7) \quad [\text{See Eqn I, Table 4}]$$

Where X is the total design intake flow (in gpm), and  
Y is the Initial Capital Costs (in U.S. dollars)

**Step 8: Calculate the Yearly Operation and Maintenance Costs.**

Using the design intake flow determined in Step 1 and the equation identified in Step 7 above, you can calculate the yearly Operation and Maintenance Costs using Equation I from Table 4 as follows:

$$Y = (-8E^{-6}(2083)^2 + 0.806(2083) + 3646.7)$$

$$Y = \$5,291$$

**Table 1. Initial Capital-Cost Equations for Phase III Technology Upgrades**

Technology Upgrade	Capital Cost Equation	Independent Variable Range		Eqn
		Max Flow (gpm)	Min Flow (gpm)	
Add Fish Handling and/or Return System to Existing Traveling Screen System	$Y=(-2E-5*X^2 + 4.5039*X + 21555)$	5000	0	A
	$Y= (-2E-6*X^2 + 2.0231*X + 26024)$	30000	5000	B
	$Y=(-9E-7*X^2 + 1.5046*X + 29971)$	6000	30000	C
	$Y=(-6E-7*X^2 + 1.7239*X + 38653)$	225000	60000	D
Add Fine Mesh Screens to Existing Traveling Screen System	$Y=(8E-9*X^3 - 0.0004*X^2 + 10.917*X + 16321)$	5000	0	E
	$Y=(3E-10*X^3 - 0.00004*X^2 + 5.481*X + 44997)$	30000	5000	F
	$Y=(5E-11*X^3 - 0.00002*X^2 + 5.0073*X + 64193)$	6000	30000	G
	$Y=(5E-11*X^3 - 0.00002*X^2 + 5.6762*X + 81695)$	225000	60000	H
Add Fine Mesh Screens and Fish Handling and/or Return System to Existing Traveling Screen System	$Y=(8E-9*X^3 - 0.0004*X^2 + 15.03*X + 33044)$	5000	0	I
	$Y=(2E-10*X^3 - 0.00003*X^2 + 6.921*X + 68688)$	30000	5000	J
	$Y=(5E-11*X^3 - 0.00002*X^2 + 6.2849*X + 88783)$	6000	30000	K
	$Y=(5E-11*X^3 - 0.00002*X^2 + 7.1477*X + 113116)$	225000	60000	L

Note: The costing equations presented in this table provide an “initial capital cost” only. To determine the “total estimated capital cost, ” retrofit factors, construction factors, additional allowances, and state-specific factors must be added to the “initial capital costs” (see Tables 2 and 3 and example calculations).

**Table 2. Construction Factors (Including a CWIS Technology Flow Sizing Factor) for Existing Facilities**

Plant Type	Compliance Cooling Water Intake Technology	Construction Factor for Scenario
Non-nuclear	Fish Handling	None
Non-nuclear	Fine Mesh Screens	30 percent
Non-nuclear	Fine Mesh Screens w/ Fish Handling	15 percent
Nuclear	Fish Handling	None
Nuclear	Fine Mesh Screens	65 percent
Nuclear	Fine Mesh Screens w/ Fish Handling	30 percent

**Table 3. State-Specific Capital Cost Factors**

<b>State</b>	<b>State Code</b>	<b>Median Weighted Cost Factor</b>	<b>State</b>	<b>State Code</b>	<b>Median Weighted Cost Factor</b>
Alaska	AK	1.245	North Carolina	NC	0.752
Alabama	AL	0.81	North Dakota	ND	0.827
Arkansas	AR	0.7815	Nebraska	NE	0.828
Arizona	AZ	0.864	New Hampshire	NH	0.913
California	CA	1.081	New Jersey	NJ	1.099
Colorado	CO	0.915	New Mexico	NM	0.912
Connecticut	CT	1.052	Nevada	NV	0.997
DC	DC	0.948	New York	NY	1.0235
Delaware	DE	1.009	Ohio	OH	0.955
Florida	FL	0.832	Oklahoma	OK	0.82
Georgia	GA	0.812	Oregon	OR	1.059
Hawaii	HI	1.225	Pennsylvania	PA	0.9765
Iowa	IA	0.886	Rhode Island	RI	1.039
Idaho	ID	0.932	South Carolina	SC	0.7385
Illinois	IL	0.994	South Dakota	SD	0.789
Indiana	IN	0.922	Tennessee	TN	0.803
Kansas	KS	0.84	Texas	TX	0.797
Kentucky	KY	0.847	Utah	UT	0.8975
Louisiana	LA	0.819	Virginia	VA	0.822
Massachusetts	MA	1.064	Vermont	VT	0.743
Maryland	MD	0.89	Washington	WA	1.028
Maine	ME	0.829	Wisconsin	WI	0.97
Michigan	MI	0.966	West Virginia	WV	0.943
Minnesota	MN	1.046	Wyoming	WY	0.787
Missouri	MO	0.925			
Mississippi	MS	0.7425	Minimum	SC	0.739
Montana	MT	0.954	Maximum	AK	1.245

**Table 4. Final O&M Cost Equations for Phase III Technology Upgrades**

Technology Upgrade	O&M Cost Equation	Independent Variable Range		Eqn
		Max Flow (gpm)	Min Flow (gpm)	
Add Fish Handling and/or Return System to Existing Traveling Screen System	$Y=(-4E-6*X^2 + 0.3025*X + 1312.7)$	5000	0	A
	$Y= (-7E-7*X^2 + 0.1273*X + 1459.7)$	30000	5000	B
	$Y=(-8E-8*X^2 + 0.0668*X + 1387.1)$	6000	30000	C
	$Y=(-6E-13*X^3 + 2E-7*X^2 + 0.0367*X + 3013)$	225000	60000	D
Add Fine Mesh to Existing Traveling Screen System	$Y=(-4E-6*X^2 + 0.5035*X + 2334)$	5000	0	E
	$Y=(-2E-6*X^2 + 0.3312*X + 3621.1)$	30000	5000	F
	$Y=(1E-11*X^3 - 3E-6*X^2 + 0.4047*X + 1359.4)$	6000	30000	G
	$Y=(4E-13*X^3 - 3E-7*X^2 + 0.1715*X + 8472.1)$	225000	60000	H
Add Fine Mesh Screens and Fish Handling and/or Return System to Existing Traveling Screens System	$Y=(-8E-6*X^2 + 0.806*X + 3646.7)$	5000	0	I
	$Y=(-3E-6*X^2 + 0.4585*X + 5080.7)$	30000	5000	J
	$Y=(-6E-7*X^2 + 0.2895*X + 5705.3)$	6000	30000	K
	$Y=(-3E-13*X^3 - 4E-8*X^2 + 0.2081*X + 11485)$	225000	60000	L

Note: The costing equations presented in this table incorporate all costs and factors.