Barge Impact Loads for the Maysville Bridge

Michael W. Whitney∗  Issam E. Harik†
James J. Griffin‡  David L. Allen∗∗

∗University of Kentucky
†University of Kentucky, harik@uky.edu
‡University of Kentucky
∗∗University of Kentucky, dallen@engr.uky.edu
This paper is posted at UKnowledge.
https://uknowledge.uky.edu/ktc_researchreports/424
Interim Research Report  
KTC-94-6

**BARGE IMPACT LOADS**  
FOR THE  
**MAYSVILLE BRIDGE**

by

Michael W. Whitney  
Regional Structural Engineer, Federal Highway Administration  
(On educational leave to pursue a Ph.D degree in Civil Engineering)

Issam E. Harik  
Professor of Civil Engineering

James J. Griffin  
Research Assistant

and

David L. Allen  
Chief Research Engineer

Kentucky Transportation Center  
College of Engineering, University of Kentucky

in cooperation with

Transportation Cabinet  
Commonwealth of Kentucky

and

Federal Highway Administration  
U.S. Department of Transportation

The contents of this report reflect the views of the authors who are responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the University of Kentucky, the Kentucky Transportation Cabinet, nor the Federal Highway Administration. This report does not constitute a standard, specification or regulation. The inclusion of manufacturer names or trade names are for identification purposes and are not to be considered as endorsement.

February 1994
This report provides the barge equivalent static load distribution data needed to apply method II of vessel impact design for the Maysville, Kentucky bridge over the Ohio River. The information provided in this report is in accordance with the AASHTO Guide Specification and Commentary for Vessel Collision Design of Highway Bridges.

A computer program was written to process the database and calculate the probability based length, width, and capacity for each barge category. Additionally, a second computer program was written to calculate the probability based number of barges in a flotilla column and row, and subsequently categorize that flotilla based upon the barge length and width categories designated by the U.S. Army Corps of Engineers. The equivalent static impact loads were then calculated using the probability based flotilla sizes and tonnages.

The results indicated 12 barge categories occurring along the Maysville section of the Ohio River. The associated frequencies and impact loads are reported. The equivalent static load for the usually neglected 290 x 54 foot barge was calculated to be a maximum of 8,140 kips with a significant frequency of occurrence of 205 downbound passages per year.
# Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>Probability Based Impact Loads for the Tower Piers</td>
<td>1</td>
</tr>
<tr>
<td>Probability Based Barge Sizes and Tonnages</td>
<td>2</td>
</tr>
<tr>
<td>Probability Based Flotilla Column and Row Count</td>
<td>3</td>
</tr>
<tr>
<td>Location of Tower Pier Impact Loads</td>
<td>4</td>
</tr>
<tr>
<td>Impact Force Equations</td>
<td>5</td>
</tr>
<tr>
<td>Minimum Impact Loads for Tower Piers</td>
<td>5</td>
</tr>
<tr>
<td>River Velocity</td>
<td>6</td>
</tr>
<tr>
<td>Vessel Velocity</td>
<td>6</td>
</tr>
<tr>
<td>Probability of Aberrancy</td>
<td>7</td>
</tr>
<tr>
<td>Design Barge Acceptance Criteria</td>
<td>7</td>
</tr>
<tr>
<td>Scour Requirements</td>
<td>8</td>
</tr>
<tr>
<td>Conclusions</td>
<td>8</td>
</tr>
<tr>
<td>Reference</td>
<td>9</td>
</tr>
<tr>
<td>Appendix I: Computer Program for Barge Capacities</td>
<td>14</td>
</tr>
<tr>
<td>Appendix II: Barge Capacity Results</td>
<td>33</td>
</tr>
<tr>
<td>Appendix III: Computer Program for Assigning the Number of Barges to Flotilla Columns and Rows</td>
<td>35</td>
</tr>
<tr>
<td>Appendix IV: Barge Distribution by Category</td>
<td>55</td>
</tr>
<tr>
<td>Appendix V: Equivalent Static Loads Calculations</td>
<td>57</td>
</tr>
</tbody>
</table>
Introduction

This report provides the barge equivalent static load distribution data needed to apply method II of vessel impact design (reference 1) for the Maysville, Kentucky bridge over the Ohio River. The information provided in this report is in accordance with the AASHTO Guide Specification and Commentary for Vessel Collision Design of Highway Bridges (reference 1). The results generated in this report are based on statistical data obtained from the U.S. Coast Guard, the U.S. Army Corps of Engineers, and the American Waterways Operators.

The AASHTO Guide Specification recommends that the impact loads from transiting flotillas be applied at the 2% flow as the water elevation. For the Maysville bridge only, the tower piers are located in the waterway at this elevation. Therefore, only the tower piers need resist the flotilla impact loads.

Probability Based Impact Loads for the Tower Piers

In order to calculate the equivalent static impact loads necessary to apply method II for vessel impact design, the barge flotillas currently using the Maysville section of the Ohio River needed to be classified into discrete categories. However, the Army Corps of Engineers reports that there are approximately 2,000 barge sizes and types currently using the U.S. inland waterway system. In addition, barge flotillas can be comprised of almost any combination and number of these barge sizes and types. Typically though, the flotilla sizes are limited by the dimensions of the locks on the waterways that the flotilla will pass through and by practical considerations such as lack of maneuverability for excessively large flotillas, etc. Also, flotillas are generally made up of mostly the same barge size and type. Nevertheless, there still is a very large variation in the flotillas using the Maysville section of the Ohio River; therefore, a probability approach was used to calculate the size, tonnage, and number of barges making up 12 flotilla categories.

It should be noted that there are 24 possible flotilla categories; however, only 12 occur on the Maysville section of the Ohio River. The 24 flotilla categories were based upon the U.S. Army Corps of Engineers designation as presented in Tables 1 and 2. Flotilla category size ranges currently using the Maysville section of the Ohio River (Mile 411) are given in Table 3 (columns 1 and 2, respectively).

The impact loads and their associated frequencies are also given in Table 3 for
the west and east tower piers (columns 4-6). The methods and databases used to calculate the values given in the Table 3 are given in the following sections of this report.

**Probability Based Barge Sizes and Tonnages**

The barge tonnages and sizes for the 12 categories are based on the information contained in the Waterborne Transportation Lines of the United States database. The database contains sizes and tonnages of every barge registered to operate in the U.S. A computer program (given in Appendix I) was written to process the database and calculate the tonnages and sizes to be assigned to the barges comprising a flotilla category. The computer calculations were based on the following assumptions:

1. The variation of the barge sizes and tonnages within a category can be represented by a normal distribution.

2. The barges using the Kentucky waterways do not exceed a loaded draft of 15.2-ft.

   The draft cutoff of 15.2-ft was based on information from the U.S. Coast Guard that barges with a draft in excess of 12-ft do not typically operate on Kentucky waterways. The 15.2-ft value was used to include some barges in the database that could conceivably operate on the Kentucky waterways during high water conditions. This will lead to reasonably conservative results.

3. The minimum of the following values is used:
   - maximum sizes, and tonnages encountered for a category within the database.
   - average sizes and tonnages plus two standard deviations calculated for a category.

   Since the variation of the barge sizes and tonnages within a category could be represented by a normal distribution, use of the average plus two standard deviations assures that the barge sizes and tonnages assigned to a category have only a 4.5% chance of being exceeded. In the cases where the maximum values within a category are used, there is 0% chance that the sizes and tonnages will be exceeded since the database contains all barges operating within the U.S.

4. Only barges typically operating on the Mississippi River System and the Gulf Coast Intercostal Waterway will be used in the calculations.
5. The barge selfweight could be linearly interpolated from the relationship:

\[
\text{self weight} = (\text{cargo capacity}) \times \left[ \frac{\text{light draft}}{\text{loaded draft} - \text{light draft}} \right]
\]  

(1)

The results from the computer program calculations are given in Appendix II.

**Probability Based Flotilla Column and Row Count**

The number of barges in a flotilla for the 12 categories is based on the information contained in the 1992 Performance Monitoring System database. The database contains information on the total number of barges by category and the total number of flotillas and their dimensions using the locks of the U.S. Waterways in 1992. It should be noted that the flotillas are not necessarily comprised of only one barge size or type. In addition, the database only contains information on the total number of barges in each flotilla and the dimensions of each flotilla. Therefore, certain assumptions must be made in order to determine the number of barges in each row and column of the flotillas and the size of the barges making up the flotilla.

A computer program (given in Appendix III) was written to process the database and calculate the number of barges to be assigned to the rows and columns of the 12 flotilla categories. The computer calculations were based on the following assumptions:

1. The variation of the number of barges comprising the rows and columns of a flotilla within a category can be represented by a normal distribution.

2. The flotilla width varies in regular increments and therefore the number of barges in the rows is determined first.

3. Barge widths do not *typically* exceed 55 feet.

4. The minimum of the following values is used:

   - maximum number of barges making up the rows and columns encountered for a category within the database.
   - average number of barges making up the rows and columns plus two standard deviations calculated for a category.

Since it was assumed that the variation of the number of barges
comprising the flotilla category rows and columns could be represented by a normal distribution, using the average plus two standard deviations indicates there is only a 4.5% chance of the values used being exceeded on a yearly basis.

5. Non-integer values for the number of barges comprising a flotilla column or row are acceptable since method II is a probability based analysis procedure.

6. Flotilla column lengths include the possibility of a barge attached to the side of the tow boat. Since tow boat tonnages are generally lower than barge tonnages, it is more conservative to replace the tow boat with a barge.

The flotilla frequency distribution for the Maysville section of the Ohio River was determined by dividing the total number of barges for each category by the average number of barges comprising each of the flotilla categories. The average number was used in place of the average plus two standard deviations since it would result in a more conservative flotilla frequency distribution. The total numbers of barges by category are given in Appendix IV. Some barge types do not occur as flotillas, rather they are incorporated in flotillas which are comprised primarily of other barge types. These categories are assigned a "zero" flotilla frequency.

For the Maysville section, upbound barges operate at only 31% of cargo capacity and travel at maximum absolute velocities (barge minus river velocity) of approximately four knots (7 fps, 5 mph). On the other hand, downbound barges travel at 93% of cargo capacities with absolute velocities (barge plus river velocity) of ten knots (17 fps, 12 mph). Consequently, impact loads and barge counts neglect upbound barge traffic since impact loads from upbound barges are insignificant compared to downbound barges.

Location of Tower Pier Impact Loads

For the substructure stability design, Section 3.15.1 of the AASHTO Guide Specification and Commentary (reference 1) is unclear as to which river flow condition the impact load should be applied. However, it seems the intent of Section 3.15.1 is to require the 2% flow elevation. The 2% flow elevation, determined from daily river flow data, is the elevation the river exceeds just 2% of the time. The 2% flow elevation should not be confused with a 2% flood event elevation, which is the elevation the river has a 2% probability of reaching for any given year.

It is recommended that the concentrated impact load be applied to the tower
pier at the 2% flow elevation of 496.5-ft. In addition, reference 1 allows for the local or impacted pier to be designed with the barge impact load applied as a uniformly distributed load. The recommended starting elevation and length of the uniform barge impact loads are given in Table 3 (columns 7 and 8) by flotilla category. These elevations are based on barge size data from the Waterborne Transportation Lines of the U.S. database (WTLUS) and the information provided in the AASHTO Guide Specification and Commentary for Vessel Collision Design of Highway Bridges. The elevations assume that the barge contacts only the tower pier columns and does not contact the substructure (e.g., pile footing, etc.).

Impact Force Equations

Currently, reference 1 provides a simple method for calculating the equivalent static barge impact force on a bridge element. The formulas are based on impact tests conducted on individual European barges. This is of concern since the tests were conducted on single barges at low velocities and not on multi-barge flotillas traveling at high velocities as found on the Ohio River.

The following exemplifies the reason for the concern. The lead barge crushing depth is required when determining the impact force. The calculations for the Ohio River barges gave crushing depths up to 39.31-ft. However, inspections of past collisions on inland waterways have shown that crushing depths rarely exceed 10-ft. These inspections have shown that energy loss occurs between individual barges due to crushing and friction. As barges crash into and ride up on each other, the amount of crushing in the lead barge is reduced, and in turn the resulting impact load is reduced.

However, in lieu of physical flotilla impact test results to provide a basis for modifying the AASHTO impact formulas (reference 1), these formulas will be used in their current form. In addition, when preliminary results from a FHWA study were used to calculate the impact load for the largest flotilla type, there was only a 15% reduction in the impact load when compared to the AASHTO impact load. Therefore, the loads are conservative but apparently not overly conservative. The calculations using the AASHTO formulas are included in Appendix V.

Minimum Impact Loads for Tower Piers

As a minimum, the AASHTO Guide Specifications require that all waterway
piers, with available water depth equal to the empty draft of a free floating barge, be
designed to resist the impact of the empty barge floating with the yearly mean current
velocity and elevation at the bridge location. However, the Kentucky Transportation
Cabinet has established the more conservative requirement of a single barge, fully
loaded or loaded to a draft equal to the available water depth, drifting at the 100-year
current as the design minimum.

The design minimum barge selected was a 53-ft x 290-ft barge since it is one
of the largest barges currently in use on the Ohio River, and barge traffic data indicate
205 downbound passages per year of flotillas with this barge type. The typical
dimensions for the 53-ft x 290-ft barge along with other barge sizes are given in Table
4. The uniform impact load, length, and bridge pier starting elevations for the single,
fully loaded barge are given in Table 5.

River Velocity

River velocity values used in the barge flotilla impact force calculations are for
2% flow at the east and west tower piers. The single free drifting barge impact forces
were calculated using the 100-year flood velocity at the tower piers. River velocities
were calculated by Palmer Engineering using a WSPRO analysis. However, the one-
dimensional WSPRO analysis will not give the river flow directions at the tower piers
necessary to determine the longitudinal and transverse components, with respect to the
bridge pier, of the barge impact force. A 2-dimensional analysis, such as the
University of Kentucky's FESWMS computer program, is required in order to
calculate flow directions.

Vessel Velocity

The vessel transit velocity (does not include river flow velocity) used in the
impact force calculations is based on data provided by the U.S. Coast Guard. The data
indicated that typical vessel transit velocities were between 5 mph (7 fps, 4 knots) to
7 mph (10 fps, 6 knots). The higher value of 7 mph was used in the calculations.

Typically the total vessel velocity at the bridge pier is calculated by adding the
transit velocity to the centerline river velocity and applying section 3.7 of the AASHTO
Guide Specifications (reference 1) to reduce the centerline velocity to the value
expected at the bridge piers. However, for the Maysville bridge the vessel transit path
width is equal to the navigation channel width.

The vessel velocities at the bridge piers are equal to the vessel velocities at the transit path centerline when calculated in accordance with section 3.7 of the AASHTO Guide Specifications. This seems conservative since the river velocity would decrease as the river bank is approached due to frictional effects. Therefore the river velocities discussed above were added to the vessel transit velocity to generate the vessel velocity at the two tower piers.

Probability of Aberrancy

Vessel accident statistics have been maintained for the last 11 years for the Ohio River. Over the past 11 years, the average probability of aberrancy for barge traffic on the Maysville bridge section of the river was $8.57 \times 10^{-4}$. It should be noted that for the years of 1990 and 1991 the average probability of aberrancy was much higher at $23.10 \times 10^{-4}$. However, AASHTO recommends using the long-term data. In addition, barge traffic increased only 1% from 1989 to 1990 and yet the probability of aberrancy increased three times. Consequently, the change in aberrancy rate was not related to a dramatic increase in barge traffic, which would warrant the use of short-term aberrancy rate, but rather to some short-term environmental factors (e.g., weather, low river levels, etc). Therefore, the 11 year average value of $8.57 \times 10^{-4}$ should be used.

Design Barge Acceptance Criteria

For the Maysville bridge, which has a critical bridge importance classification, the acceptable annual frequency ($AF_c$) of collapse shall be less than or equal to 0.01 in 100 years or $AF_c = 0.0001$. The annual frequency of bridge collapse is distributed, either equally or at the designers discretion, over all piers that are located within the waterway. However, it is recommended that the $AF_c$ be distributed to each pier based on its percentage value of the replacement cost of the structure.

For the Maysville bridge, however, only the two tower piers will be in the waterway for the 2% flow elevation. Therefore, the acceptable annual frequency of collapse for each tower pier ($AF_p$) should be;
\[ AF_p = \left( \frac{1.0}{2} \right) (AF_e) = \left( \frac{1.0}{2} \right) (0.0001) = 0.00005 \]

The summation of the annual frequencies of collapse for all barge size categories, with respect to the individual tower piers, should then be less than or equal to 0.00005. In addition to the probability of aberrancy provided in the previous section, the data required for generating the annual frequencies of collapse for all barge size categories is provided in Table 3.

**Scour Requirements**

The current AASHTO Guide Specifications do not provide guidance on the application of scour to the barge impact design of bridges. However, in a letter dated September 4, 1992 the FHWA Region 4 office directed the application of the following scour conditions to the impact design using the AASHTO method II:

1. For impact loads applied at normal vessel operating conditions, two scour conditions should be evaluated. The first is the scour having a probability of 1.0, most likely only the long-term scour plus the contraction and local scour caused by a Q_5 event. The second is the maximum anticipated scour (or other critical value determined by the designer), and the probability of this scour occurring during the life of the bridge should be included in the calculations.

2. For the case of the free-floating empty barge on the 100-year flood, the maximum anticipated scour should be used.

Therefore, it is recommended that the impact loads for the loaded barge flotillas given in Table 3 be applied in conjunction with 100\% of long-term scour plus the local scour caused by a Q_3 (five year return period) flood event. The impact loads for the single free-floating barge given in Table 5 should be applied with the scour caused by the Q_{100} flood event.

**Conclusions**

The equivalent static loads and their associated frequencies have been derived for the Maysville Bridge over the Ohio River in accordance with the requirements of method II of the AASHTO Guide Specifications (reference 1). The impact loads calculated using the AASHTO formulas are probably conservative. However, in lieu
of physical flotilla impact test results to provide a basis for modification, the AASHTO formulas were used in their current form.

There is a tremendous variation in the size and types of barges and flotillas in use on the Ohio River. Based on the procedures used in this report, there are currently 12 flotilla categories on the Maysville section of the Ohio River. The flotilla sizes and tonnages used to calculate the equivalent static loads for each category have at most a 4.5% chance that a flotilla will pass the Maysville Bridge with greater size or load. Finally, calculations for the equivalent static loads indicated that some categories may be combined since they result in nearly identical impact loads.

Reference

Table 1: Length of Barge Designation

<table>
<thead>
<tr>
<th>Length of Barge</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>less than 100 feet</td>
</tr>
<tr>
<td>B</td>
<td>100 to 174 feet</td>
</tr>
<tr>
<td>C</td>
<td>175 to 194 feet</td>
</tr>
<tr>
<td>D</td>
<td>195 to 199 feet</td>
</tr>
<tr>
<td>E</td>
<td>200 to 259 feet</td>
</tr>
<tr>
<td>F</td>
<td>260 to 289 feet</td>
</tr>
<tr>
<td>G</td>
<td>290 to 300 feet</td>
</tr>
<tr>
<td>H</td>
<td>greater than 300 feet</td>
</tr>
</tbody>
</table>

Table 2: Width of Barge Designation

<table>
<thead>
<tr>
<th>Width of Barge</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>less than 26 feet</td>
</tr>
<tr>
<td>B</td>
<td>26 to 34 feet</td>
</tr>
<tr>
<td>C</td>
<td>35 to 54 feet</td>
</tr>
<tr>
<td>D</td>
<td>greater than 54 feet</td>
</tr>
</tbody>
</table>
Table 3: Equivalent static barge impact loads and frequencies for the west and east tower piers for the Maysville, Kentucky bridge.

<table>
<thead>
<tr>
<th>Flotilla Category(^a)</th>
<th>Barge Size Range for Flotilla Category</th>
<th>Number of Barges in Flotilla Column(^b)</th>
<th>Flotilla Frequency (number of passages per year)(^c)</th>
<th>Equivalent Static Impact Force for West Tower Pier (kips)</th>
<th>Equivalent Static Impact Force for East Tower Pier (kips)</th>
<th>Starting Elevation of Uniform Barge Impact Load (ft)</th>
<th>Length of Uniform Barge Impact Load (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (BB)</td>
<td>(100'-174') x (26'-34')</td>
<td>3.33</td>
<td>4</td>
<td>3,380</td>
<td>3,450</td>
<td>499.5</td>
<td>3.0</td>
</tr>
<tr>
<td>2 (BC)</td>
<td>(100'-174') x (35'-54')</td>
<td>3.42</td>
<td>105</td>
<td>7,170</td>
<td>7,320</td>
<td>499.5</td>
<td>3.0</td>
</tr>
<tr>
<td>3 (CC)</td>
<td>(175'-194') x (35'-54')</td>
<td>3.35</td>
<td>46</td>
<td>6,940</td>
<td>7,080</td>
<td>499.5</td>
<td>3.0</td>
</tr>
<tr>
<td>4 (DB)</td>
<td>(195'-199') x (26'-34')</td>
<td>5.00</td>
<td>25</td>
<td>4,230</td>
<td>4,330</td>
<td>499.5</td>
<td>3.0</td>
</tr>
<tr>
<td>5 (DC)</td>
<td>(195'-199') x (35'-54')</td>
<td>4.58</td>
<td>2076</td>
<td>5,640</td>
<td>5,760</td>
<td>499.5</td>
<td>3.0</td>
</tr>
<tr>
<td>6 (DD)</td>
<td>(195'-199') x (&gt;54')</td>
<td>6.00</td>
<td>1</td>
<td>6,480</td>
<td>6,620</td>
<td>500.5</td>
<td>4.0</td>
</tr>
<tr>
<td>7 (EB)</td>
<td>(200'-259') x (26'-34')</td>
<td>5.00</td>
<td>1</td>
<td>3,610</td>
<td>3,700</td>
<td>499.5</td>
<td>3.0</td>
</tr>
<tr>
<td>8 (EC)</td>
<td>(200'-259') x (35'-54')</td>
<td>4.58</td>
<td>195</td>
<td>6,160</td>
<td>6,290</td>
<td>499.5</td>
<td>3.0</td>
</tr>
<tr>
<td>9 (FC)</td>
<td>(260'-289') x (35'-54')</td>
<td>3.35</td>
<td>5</td>
<td>7,700</td>
<td>7,860</td>
<td>499.5</td>
<td>3.0</td>
</tr>
<tr>
<td>10 (GC)</td>
<td>(290'-300') x (35'-54')</td>
<td>3.39</td>
<td>205</td>
<td>7,970</td>
<td>8,140</td>
<td>500.5</td>
<td>4.0</td>
</tr>
<tr>
<td>11 (HC)</td>
<td>(&gt;300') x (35'-54')</td>
<td>2.00</td>
<td>5</td>
<td>8,120</td>
<td>8,290</td>
<td>500.5</td>
<td>4.0</td>
</tr>
<tr>
<td>12 (HD)</td>
<td>(&gt;300') x (&gt;54')</td>
<td>1.67</td>
<td>19</td>
<td>6,100</td>
<td>6,120</td>
<td>500.5</td>
<td>4.0</td>
</tr>
</tbody>
</table>

a: The first letter in parentheses refers to the length of barge designation as presented in Table 2, and the second letter in parentheses refers to the width of barge designation as presented in Table 3.

b: Non-integer values for the number of barges comprising a flotilla column are acceptable since method II is a probability based method of analysis.


d: For both the west and east tower piers.
Table 4: Typical barge size dimensions.

<table>
<thead>
<tr>
<th>Length $L_a$ (ft)</th>
<th>Width $B_m$ (ft)</th>
<th>Depth $D_v$ (ft)</th>
<th>Empty Draft $D_E$ (ft)</th>
<th>Loaded Draft $D_L$ (ft)</th>
<th>Depth of Bow $D_b$ (ft)</th>
<th>Bow Rake Length $R_l$ (ft)</th>
<th>Head Log Height $H_L$ (ft)</th>
<th>Cargo Weight $C_v$ (tons)</th>
<th>Empty Weight $W_e$ (tons)</th>
<th>Total Weight $W_t$ (tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>195</td>
<td>35</td>
<td>12</td>
<td>1.7</td>
<td>8.7</td>
<td>13</td>
<td>20</td>
<td>2-3</td>
<td>1700</td>
<td>200</td>
<td>1900</td>
</tr>
<tr>
<td>290</td>
<td>53</td>
<td>12</td>
<td>1.7</td>
<td>8.7</td>
<td>13</td>
<td>25</td>
<td>2-3</td>
<td>3700</td>
<td>600</td>
<td>4300</td>
</tr>
<tr>
<td>250</td>
<td>72</td>
<td>17</td>
<td>2.5</td>
<td>12.5</td>
<td>18</td>
<td>30</td>
<td>3-5</td>
<td>5000</td>
<td>1300</td>
<td>6300</td>
</tr>
</tbody>
</table>

**PLAN**

**ELEVATION**
Table 5: Equivalent static impact loads for the west and east tower piers for a single free floating 53-ft x 290-ft barge.

<table>
<thead>
<tr>
<th>Uniform Barge Impact Load Starting Elevation (ft)</th>
<th>Uniform Barge Impact Load Length (ft)</th>
<th>Equivalent Static Impact Force West Pier (kips)</th>
<th>Equivalent Static Impact Force East Pier (kips)</th>
</tr>
</thead>
<tbody>
<tr>
<td>500.5</td>
<td>4.0</td>
<td>2,790</td>
<td>2,850</td>
</tr>
</tbody>
</table>
Appendix I:

Computer Program for Barge Capacities
READS BARGE CHARACTERISTIC FILE AND SUMS AVERAGE BARGE CAPACITIES
BASED ON LENGTH/WIDTH CATEGORY

CALCULATES CAPACITIES, LENGTHS, AND WIDTHS AS AVERAGE PLUS TWO
STANDARD DEVIATIONS

FINDS MAXIMUM CATEGORY CHARACTERISTICS

PRINTS MINIMUM OF AVERAGE BARGE CHARACTERISTIC PLUS TWO
STANDARD DEVIATIONS OR MAXIMUM VALUE FOUND IN CATEGORY

BY: MICHAEL W. WHITNEY
UNIVERSITY OF KENTUCKY
LEXINGTON, KY

BLENGTH = BARGE LENGTH
BWIDTH = BARGE WIDTH
CAPACITY = BARGE CARGO CAPACITY + SELF WEIGHT
DRAFT = LOADED DRAFT OF THE BARGE WHICH IS ASSUMED TO BE < 15.2'
IAREA = LOCATION THE BARGE OPERATES (FOR KENTUCKY = 4)

IMPLICIT REAL(A-H,L-Z), INTEGER(I-K)

OPEN (1, FILE = 'C: \F32\WATER.DAT')
OPEN (2, FILE = 'C: \F32\WATERBRN.OUT')

DO WHILE(.NOT.EOF(1))

READ (1,*) BLENGTH, BWIDTH, CAPACITY, LOADDRAFT, LIGHTDRAFT, IAREA

1 IF (BLENGTH.GT.10. .AND. BLENGTH.LT.100. .AND. BWIDTH.GT.10. .AND.
2 BWIDTH.LT.26. .AND. IAREA.EQ.4 .AND. LOADDRAFT.LT.15.2 .AND.
3 CAPACITY.GT.10.0 .AND. LOADDRAFT .GT. LIGHTDRAFT ) THEN

CAPACITY=CAPACITY+(LIGHTDRAFT/(LOADDRAFT-LIGHTDRAFT)) *CAPACITY
AACCOUNT=AACCOUNT +1
AACAPACITY=AACAPACITY+CAPACITY
AALength=AALength+BLENGTH
AAWIDTH=AAWIDTH+BWIDTH
AAMAXCAPACITY=MAX(AAMAXCAPACITY, CAPACITY)
AAMAXLENGTH=MAX(AAMAXLENGTH, BLENGTH)
AAMAXWIDTH=MAX(AAMAXWIDTH, BWIDTH)

ENDIF

2 IF (BLENGTH.GT.10. .AND. BLENGTH.LT.100. .AND. BWIDTH.GE.26. .AND.
1 BWIDTH.LT.35.0 .AND. IAREA.EQ.4 .AND. LOADDRAFT.LT.15.2 .AND.
2 CAPACITY.GT.99.0 .AND. CAPACITY .LT. 10000.0 .AND. LOADDRAFT
3 .GT. LIGHTDRAFT) THEN
\[
\text{CAPACITY} = \text{CAPACITY} + \left( \frac{\text{LIGHTDRAFT}}{\text{LOADDRAFT} - \text{LIGHTDRAFT}} \right) \times \text{CAPACITY}
\]

\[
\text{ACCOUNT} = \text{ACCOUNT} + 1
\]

\[
\text{ACCAPACITY} = \text{ACCAPACITY} + \text{CAPACITY}
\]

\[
\text{ACLENGTH} = \text{ACLENGTH} + \text{BLENGTH}
\]

\[
\text{ACWIDTH} = \text{ACWIDTH} + \text{BWIDTH}
\]

\[
\text{ACMAXCAPACITY} = \max(\text{ACMAXCAPACITY}, \text{CAPACITY})
\]

\[
\text{ACMAXLENGTH} = \max(\text{ACMAXLENGTH}, \text{BLENGTH})
\]

\[
\text{ACMAXWIDTH} = \max(\text{ACMAXWIDTH}, \text{BWIDTH})
\]

\[
\text{ENDIF}
\]

\[
\text{3 IF } (\text{BLENGTH} \geq 10 \text{ AND } \text{BLENGTH} < 100 \text{ AND } \text{BWIDTH} \geq 35.0 \text{ AND } \text{BWIDTH} < 79.0 \text{ AND } \text{IAREA} = 4 \text{ AND } \text{LOADDRAFT} < 15.2 \text{ AND } \text{CAPACITY} > 99.0 \text{ AND } \text{CAPACITY} < 5000.0 \text{ AND } \text{LOADDRAFT} > \text{LIGHTDRAFT}) \text{ THEN}
\]

\[
\text{CAPACITY} = \text{CAPACITY} + \left( \frac{\text{LIGHTDRAFT}}{\text{LOADDRAFT} - \text{LIGHTDRAFT}} \right) \times \text{CAPACITY}
\]

\[
\text{ACCOUNT} = \text{ACCOUNT} + 1
\]

\[
\text{ACCAPACITY} = \text{ACCAPACITY} + \text{CAPACITY}
\]

\[
\text{ACLENGTH} = \text{ACLENGTH} + \text{BLENGTH}
\]

\[
\text{ACWIDTH} = \text{ACWIDTH} + \text{BWIDTH}
\]

\[
\text{ACMAXCAPACITY} = \max(\text{ACMAXCAPACITY}, \text{CAPACITY})
\]

\[
\text{ACMAXLENGTH} = \max(\text{ACMAXLENGTH}, \text{BLENGTH})
\]

\[
\text{ACMAXWIDTH} = \max(\text{ACMAXWIDTH}, \text{BWIDTH})
\]

\[
\text{ENDIF}
\]

\[
\text{4 IF } (\text{BLENGTH} \geq 10 \text{ AND } \text{BLENGTH} < 100 \text{ AND } \text{BWIDTH} \geq 35.0 \text{ AND } \text{BWIDTH} < 79.0 \text{ AND } \text{IAREA} = 4 \text{ AND } \text{LOADDRAFT} < 15.2 \text{ AND } \text{CAPACITY} > 99.0 \text{ AND } \text{CAPACITY} < 10000.0 \text{ AND } \text{LOADDRAFT} > \text{LIGHTDRAFT}) \text{ THEN}
\]

\[
\text{CAPACITY} = \text{CAPACITY} + \left( \frac{\text{LIGHTDRAFT}}{\text{LOADDRAFT} - \text{LIGHTDRAFT}} \right) \times \text{CAPACITY}
\]

\[
\text{ACCOUNT} = \text{ACCOUNT} + 1
\]

\[
\text{ACCAPACITY} = \text{ACCAPACITY} + \text{CAPACITY}
\]

\[
\text{ACLENGTH} = \text{ACLENGTH} + \text{BLENGTH}
\]

\[
\text{ACWIDTH} = \text{ACWIDTH} + \text{BWIDTH}
\]

\[
\text{ACMAXCAPACITY} = \max(\text{ACMAXCAPACITY}, \text{CAPACITY})
\]

\[
\text{ACMAXLENGTH} = \max(\text{ACMAXLENGTH}, \text{BLENGTH})
\]

\[
\text{ACMAXWIDTH} = \max(\text{ACMAXWIDTH}, \text{BWIDTH})
\]

\[
\text{ENDIF}
\]

\[
\text{5 IF } (\text{BLENGTH} \geq 100 \text{ AND } \text{BLENGTH} \leq 174 \text{ AND } \text{BWIDTH} \geq 26.0 \text{ AND } \text{BWIDTH} < 35.0 \text{ AND } \text{IAREA} = 4 \text{ AND } \text{LOADDRAFT} < 15.2 \text{ AND } \text{CAPACITY} > 99.0 \text{ AND } \text{CAPACITY} < 10000.0 \text{ AND } \text{LOADDRAFT} > \text{LIGHTDRAFT}) \text{ THEN}
\]

\[
\text{CAPACITY} = \text{CAPACITY} + \left( \frac{\text{LIGHTDRAFT}}{\text{LOADDRAFT} - \text{LIGHTDRAFT}} \right) \times \text{CAPACITY}
\]

\[
\text{BACCOUNT} = \text{BACCOUNT} + 1
\]

\[
\text{BACAPACITY} = \text{BACAPACITY} + \text{CAPACITY}
\]

\[
\text{BACLENGTH} = \text{BACLENGTH} + \text{BLENGTH}
\]

\[
\text{BWIDTH} = \text{BWIDTH} + \text{BWIDTH}
\]

\[
\text{BACAPACITY} = \max(\text{BACAPACITY}, \text{CAPACITY})
\]

\[
\text{BAMAXCAPACITY} = \max(\text{BAMAXCAPACITY}, \text{CAPACITY})
\]

\[
\text{BAMAXLENGTH} = \max(\text{BAMAXLENGTH}, \text{BLENGTH})
\]

\[
\text{BAMAXWIDTH} = \max(\text{BAMAXWIDTH}, \text{BWIDTH})
\]

\[
\text{ENDIF}
\]

\[
\text{6 IF } (\text{BLENGTH} \geq 100 \text{ AND } \text{BLENGTH} \leq 174 \text{ AND } \text{BWIDTH} \geq 26.0 \text{ AND } \text{BWIDTH} < 35.0 \text{ AND } \text{IAREA} = 4 \text{ AND } \text{LOADDRAFT} < 15.2 \text{ AND } \text{CAPACITY} > 99.0 \text{ AND } \text{CAPACITY} < 10000.0 \text{ AND } \text{LOADDRAFT} > \text{LIGHTDRAFT}) \text{ THEN}
\]
CAPACITY = \text{CAPACITY} + \left( \frac{\text{LIGHTDRAFT}}{\text{LOADDRAFT} - \text{LIGHTDRAFT}} \right) \cdot \text{CAPACITY}

\text{BBCOUNT} = \text{BBCOUNT} + 1
\text{BBLENGTH} = \text{BBLENGTH} + \text{BLENGTH}
\text{BBWIDTH} = \text{BBWIDTH} + \text{BWIDTH}
\text{BBCAPACITY} = \text{BBCAPACITY} + \text{CAPACITY}
\text{BBMAXCAPACITY} = \max(\text{BBMAXCAPACITY}, \text{CAPACITY})
\text{BBMAXLENGTH} = \max(\text{BBMAXLENGTH}, \text{BLENGTH})
\text{BBMAXWIDTH} = \max(\text{BBMAXWIDTH}, \text{BWIDTH})

\text{END IF}

\begin{align*}
7 & \text{IF } (\text{BLENGTH} \geq 100 \text{ AND } \text{BLENGTH} \leq 174 \text{ AND } \text{BWIDTH} \geq 35 \text{ AND } \text{BWIDTH} \leq 54 \text{ AND } \text{IAREA} = 4 \text{ AND } \text{LOADDRAFT} < 15.2 \text{ AND } \\
& \quad \text{CAPACITY} > 99 \text{ AND } \text{CAPACITY} < 10000 \text{ AND } \text{LOADDRAFT} > \text{LIGHTDRAFT} \text{ THEN } \\
& \quad \text{CAPACITY} = \text{CAPACITY} + \left( \frac{\text{LIGHTDRAFT}}{\text{LOADDRAFT} - \text{LIGHTDRAFT}} \right) \cdot \text{CAPACITY} \\
& \quad \text{BCCOUNT} = \text{BCCOUNT} + 1 \\
& \quad \text{BLENGTH} = \text{BLENGTH} + \text{BLENGTH} \\
& \quad \text{BWIDTH} = \text{BWIDTH} + \text{BWIDTH} \\
& \quad \text{BCCAPACITY} = \text{BCAPACITY} + \text{CAPACITY} \\
& \quad \text{BCMAXCAPACITY} = \max(\text{BCMAXCAPACITY}, \text{CAPACITY}) \\
& \quad \text{BCMAXLENGTH} = \max(\text{BCMAXLENGTH}, \text{BLENGTH}) \\
& \quad \text{BCMAXWIDTH} = \max(\text{BCMAXWIDTH}, \text{BWIDTH}) \\
& \text{END IF}
\end{align*}

\begin{align*}
8 & \text{IF } (\text{BLENGTH} \geq 175 \text{ AND } \text{BLENGTH} \leq 194 \text{ AND } \text{BWIDTH} \geq 26 \text{ AND } \\
& \quad \text{BWIDTH} \leq 35 \text{ AND } \text{IAREA} = 4 \text{ AND } \text{LOADDRAFT} < 15.2 \text{ AND } \\
& \quad \text{CAPACITY} > 99 \text{ AND } \text{CAPACITY} < 10000 \text{ AND } \text{LOADDRAFT} > \text{LIGHTDRAFT} \text{ THEN } \\
& \quad \text{CAPACITY} = \text{CAPACITY} + \left( \frac{\text{LIGHTDRAFT}}{\text{LOADDRAFT} - \text{LIGHTDRAFT}} \right) \cdot \text{CAPACITY} \\
& \quad \text{BCCOUNT} = \text{BCCOUNT} + 1 \\
& \quad \text{BLENGTH} = \text{BLENGTH} + \text{BLENGTH} \\
& \quad \text{BWIDTH} = \text{BWIDTH} + \text{BWIDTH} \\
& \quad \text{BCCAPACITY} = \text{BCAPACITY} + \text{CAPACITY} \\
& \quad \text{BCMAXCAPACITY} = \max(\text{BCMAXCAPACITY}, \text{CAPACITY}) \\
& \quad \text{BCMAXLENGTH} = \max(\text{BCMAXLENGTH}, \text{BLENGTH}) \\
& \quad \text{BCMAXWIDTH} = \max(\text{BCMAXWIDTH}, \text{BWIDTH}) \\
& \text{END IF}
\end{align*}

\begin{align*}
9 & \text{IF } (\text{BLENGTH} \geq 175 \text{ AND } \text{BLENGTH} \leq 194 \text{ AND } \text{BWIDTH} \geq 35 \text{ AND } \\
& \quad \text{BWIDTH} \leq 54 \text{ AND } \text{IAREA} = 4 \text{ AND } \text{LOADDRAFT} < 15.2 \text{ AND } \\
& \quad \text{CAPACITY} > 99 \text{ AND } \text{CAPACITY} < 10000 \text{ AND } \text{LOADDRAFT} > \text{LIGHTDRAFT} \text{ THEN } \\
& \quad \text{CAPACITY} = \text{CAPACITY} + \left( \frac{\text{LIGHTDRAFT}}{\text{LOADDRAFT} - \text{LIGHTDRAFT}} \right) \cdot \text{CAPACITY} \\
& \quad \text{CBCOUNT} = \text{CBCOUNT} + 1 \\
& \quad \text{CLENGTH} = \text{CLENGTH} + \text{BLENGTH} \\
& \quad \text{BWIDTH} = \text{BWIDTH} + \text{BWIDTH} \\
& \quad \text{CCAPEAPACITY} = \text{CCAPACITY} + \text{CAPACITY} \\
& \quad \text{CBMAXCAPACITY} = \max(\text{CBMAXCAPACITY}, \text{CAPACITY}) \\
& \quad \text{CBMAXLENGTH} = \max(\text{CBMAXLENGTH}, \text{BLENGTH}) \\
& \quad \text{CBMAXWIDTH} = \max(\text{CBMAXWIDTH}, \text{BWIDTH}) \\
& \text{END IF}
\end{align*}

\begin{align*}
10 & \text{IF } (\text{BLENGTH} \geq 175 \text{ AND } \text{BLENGTH} \leq 194 \text{ AND } \text{BWIDTH} \geq 35 \text{ AND } \\
& \quad \text{BWIDTH} \leq 54 \text{ AND } \text{IAREA} = 4 \text{ AND } \text{LOADDRAFT} < 15.2 \text{ AND } \\
& \quad \text{CAPACITY} > 99 \text{ AND } \text{CAPACITY} < 10000 \text{ AND } \text{LOADDRAFT} > \text{LIGHTDRAFT} \text{ THEN } \\
& \quad \text{CAPACITY} = \text{CAPACITY} + \left( \frac{\text{LIGHTDRAFT}}{\text{LOADDRAFT} - \text{LIGHTDRAFT}} \right) \cdot \text{CAPACITY}
\end{align*}
CCCOUNT = CCCOUNT + 1
CCLENGTH = CCLength + BLENGTH
CCWIDTH = CCWIDTH + BWIDTH
CCCAPACITY = CCCAPACITY + CAPACITY
CCMAXCAPACITY = MAX(CCMAXCAPACITY, CAPACITY)
CCMAXLENGTH = MAX(CCMAXLENGTH, BLENGTH)
CCMAXWIDTH = MAX(CCMAXWIDTH, BWIDTH)
ENDIF

11 IF (BLENGTH .GE. 175.0 .AND. BLENGTH .LE. 194.0 .AND. BWIDTH .LE. 79.0 .AND. IAREA .EQ. 4 .AND. LOADDRAFT .LT. 15.2 .AND. CAPACITY .GT. 99.0 .AND. CAPACITY .LT. 10000.0 .AND. LOADDRAFT .GT. LIGHTDRAFT) THEN
   
   CAPACITY = CAPACITY + (LIGHTDRAFT / (LOADDRAFT - LIGHTDRAFT)) * CAPACITY
   DCCOUNT = DCCOUNT + 1
   DCLength = DCLength + BLENGTH
   DCWIDTH = DCWIDTH + BWIDTH
   DCCAPACITY = DCCAPACITY + CAPACITY
   DCMAXCAPACITY = MAX(DCMAXCAPACITY, CAPACITY)
   DCMAXLENGTH = MAX(DCMAXLENGTH, BLENGTH)
   DCMAXWIDTH = MAX(DCMAXWIDTH, BWIDTH)
ENDIF

12 IF (BLENGTH .GE. 195.0 .AND. BLENGTH .LE. 199.0 .AND. BWIDTH .GE. 35.0 .AND. BWIDTH .LE. 54.0 .AND. IAREA .EQ. 4 .AND. LOADDRAFT .LT. 15.2 .AND. CAPACITY .GT. 99.0 .AND. CAPACITY .LT. 10000.0 .AND. LOADDRAFT .GT. LIGHTDRAFT) THEN
   
   CAPACITY = CAPACITY + (LIGHTDRAFT / (LOADDRAFT - LIGHTDRAFT)) * CAPACITY
   DCCOUNT = DCCOUNT + 1
   DCLength = DCLength + BLENGTH
   DCWIDTH = DCWIDTH + BWIDTH
   DCCAPACITY = DCCAPACITY + CAPACITY
   DCMAXCAPACITY = MAX(DCMAXCAPACITY, CAPACITY)
   DCMAXLENGTH = MAX(DCMAXLENGTH, BLENGTH)
   DCMAXWIDTH = MAX(DCMAXWIDTH, BWIDTH)
ENDIF

13 IF (BLENGTH .GE. 195.0 .AND. BLENGTH .LE. 199.0 .AND. BWIDTH .GE. 35.0 .AND. BWIDTH .LE. 54.0 .AND. IAREA .EQ. 4 .AND. LOADDRAFT .LT. 15.2 .AND. CAPACITY .GT. 99.0 .AND. CAPACITY .LT. 10000.0 .AND. LOADDRAFT .GT. LIGHTDRAFT) THEN
   
   CAPACITY = CAPACITY + (LIGHTDRAFT / (LOADDRAFT - LIGHTDRAFT)) * CAPACITY
   DCCOUNT = DCCOUNT + 1
   DCLength = DCLength + BLENGTH
   DCWIDTH = DCWIDTH + BWIDTH
   DCCAPACITY = DCCAPACITY + CAPACITY
   DCMAXCAPACITY = MAX(DCMAXCAPACITY, CAPACITY)
   DCMAXLENGTH = MAX(DCMAXLENGTH, BLENGTH)
   DCMAXWIDTH = MAX(DCMAXWIDTH, BWIDTH)
ENDIF

14 IF (BLENGTH .GE. 195.0 .AND. BLENGTH .LE. 199.0 .AND. BWIDTH .GE. 54.0 .AND. BWIDTH .LE. 79.0 .AND. IAREA .EQ. 4 .AND. LOADDRAFT .LT. 15.2 .AND. CAPACITY .GT. 99.0 .AND. CAPACITY .LT. 10000.0 .AND. LOADDRAFT .GT. LIGHTDRAFT) THEN
   
   CAPACITY = CAPACITY + (LIGHTDRAFT / (LOADDRAFT - LIGHTDRAFT)) * CAPACITY
   DCCOUNT = DCCOUNT + 1
DDLENGTH = DDDLENGTH + BLENGTH
DDWIDTH = DDDWIDTH + BWIDTH
DDCAPACITY = DDCAPACITY + CAPACITY
DDMAXCAPACITY = MAX (DDMAXCAPACITY, CAPACITY)
DDMAXLENGTH = MAX (DDMAXLENGTH, BLENGTH)
DDMAXWIDTH = MAX (DDMAXWIDTH, BWIDTH)

ENDIF

15 IF (BLENGTH.GE.200 .AND. BLENGTH.LE.259 .AND. BWIDTH.GT.10 .AND. BWIDTH.LT.26 .AND. IAREA.EQ.4 .AND. LOADDRAFT.LT.15.2 .AND. CAPACITY.GT.99.0 .AND. CAPACITY.LT.10000.0 .AND. LOADDRAFT.GT.LIGHTDRAFT) THEN
CAPACITY = CAPACITY + (LIGHTDRAFT/(LOADDRAFT-LIGHTDRAFT)) * CAPACITY
EACOUNT = EACOUNT + 1
EALENGTH = EALENGTH + BLENGTH
EAWIDTH = EAWIDTH + BWIDTH
EACAPACITY = EACAPACITY + CAPACITY
EAMAXCAPACITY = MAX (EAMAXCAPACITY, CAPACITY)
EAMAXLENGTH = MAX (EAMAXLENGTH, BLENGTH)
EAMAXWIDTH = MAX (EAMAXWIDTH, BWIDTH)

ENDIF

16 IF (BLENGTH.GE.200 .AND. BLENGTH.LE.259 .AND. BWIDTH.GE.26 .AND. BWIDTH.LT.35.0 .AND. IAREA.EQ.4 .AND. LOADDRAFT.LT.15.2 .AND. CAPACITY.GT.99.0 .AND. CAPACITY.LT.10000.0 .AND. LOADDRAFT.GT.LIGHTDRAFT) THEN
CAPACITY = CAPACITY + (LIGHTDRAFT/(LOADDRAFT-LIGHTDRAFT)) * CAPACITY
BECOUNT = BECOUNT + 1
EBLENGTH = EBLENGTH + BLENGTH
EBWIDTH = EBWIDTH + BWIDTH
EBCAPACITY = EBCAPACITY + CAPACITY
EBMAXCAPACITY = MAX (EBMAXCAPACITY, CAPACITY)
EBMAXLENGTH = MAX (EBMAXLENGTH, BLENGTH)
EBMAXWIDTH = MAX (EBMAXWIDTH, BWIDTH)

ENDIF

17 IF (BLENGTH.GE.200 .AND. BLENGTH.LE.259 .AND. BWIDTH.GE.35.0 .AND. BWIDTH.LE.54.0 .AND. IAREA.EQ.4 .AND. LOADDRAFT.LT.15.2 .AND. CAPACITY.GT.99.0 .AND. CAPACITY.LT.10000.0 .AND. LOADDRAFT.GT.LIGHTDRAFT) THEN
CAPACITY = CAPACITY + (LIGHTDRAFT/(LOADDRAFT-LIGHTDRAFT)) * CAPACITY
ECCOUNT = ECCOUNT + 1
ECLENGTH = ECLength + BLENGTH
ECWIDTH = ECwidth + BWIDTH
ECCAPACITY = ECCAPACITY + CAPACITY
ECMAXCAPACITY = MAX (ECMAXCAPACITY, CAPACITY)
ECMAXLENGTH = MAX (ECMAXLENGTH, BLENGTH)
ECMAXWIDTH = MAX (ECMAXWIDTH, BWIDTH)

ENDIF

18 IF (BLENGTH.GE.200 .AND. BLENGTH.LE.259 .AND. BWIDTH.GT.54.0 .AND. BWIDTH.LE.79 .AND. IAREA.EQ.4 .AND. LOADDRAFT.LT.15.2 .AND. CAPACITY.GT.99.0 .AND. CAPACITY.LT.10000.0 .AND. LOADDRAFT.GT.LIGHTDRAFT) THEN
CAPACITY = CAPACITY + (LIGHTDRAFT/(LOADDRAFT-LIGHTDRAFT)) * CAPACITY
EDCOUNT = EDCOUNT + 1
EDLENGTH = EDLENGTH + BLENGTH

19
\[
\text{EDWIDTH} = \text{EDWIDTH} + \text{BWIDTH} \\
\text{EDCAPACITY} = \text{EDCAPACITY} + \text{CAPACITY} \\
\text{EDMAXCAPACITY} = \text{MAX}(\text{EDMAXCAPACITY}, \text{CAPACITY}) \\
\text{EDMAXLENGTH} = \text{MAX}(\text{EDMAXLENGTH}, \text{BLENGTH}) \\
\text{EDMAXWIDTH} = \text{MAX}(\text{EDMAXWIDTH}, \text{BWIDTH})
\]

ENDIF

19 IF (BLENGTH.GE.260..AND.BLENGTH.LE.289..AND.BWIDTH.GE.35.0..AND.
1 \quad \text{BWIDTH.LE.54.0..AND. IAREA.EQ.4..AND. LOADDRAFT.LT.15.2 ..AND.}
2 \quad \text{CAPACITY.GT.99.0..AND. CAPACITY. LT. 10000.0 .AND. LOADDRAFT}
3 \quad \text{GT.LIGHTDRAFT) THEN}

\text{CAPACITY} = \text{CAPACITY} + (\text{LIGHTDRAFT} / (\text{LOADDRAFT} - \text{LIGHTDRAFT})) \times \text{CAPACITY}

\text{FCOUNT} = \text{FCOUNT} + 1
\text{FCLength} = \text{FCLength} + \text{BLENGTH}
\text{FCWidth} = \text{FCWidth} + \text{BWIDTH}
\text{FCAPACITY} = \text{FCAPACITY} + \text{CAPACITY}
\text{FCMAXCAPACITY} = \text{MAX}(\text{FCMAXCAPACITY}, \text{CAPACITY})
\text{FCMAXLENGTH} = \text{MAX}(\text{FCMAXLENGTH}, \text{BLENGTH})
\text{FCMAXWIDTH} = \text{MAX}(\text{FCMAXWIDTH}, \text{BWIDTH})

ENDIF

20 IF (BLENGTH.GE.260..AND.BLENGTH.LE.289..AND.BWIDTH.GE.35.0..AND.
1 \quad \text{BWIDTH.LE.54.0..AND. IAREA.EQ.4..AND. LOADDRAFT.LT.15.2 ..AND.}
2 \quad \text{CAPACITY.GT.99.0..AND. CAPACITY. LT. 10000.0 .AND. LOADDRAFT}
3 \quad \text{GT.LIGHTDRAFT}) THEN

\text{CAPACITY} = \text{CAPACITY} + (\text{LIGHTDRAFT} / (\text{LOADDRAFT} - \text{LIGHTDRAFT})) \times \text{CAPACITY}

\text{FDCOUNT} = \text{FDCOUNT} + 1
\text{FDLength} = \text{FDLength} + \text{BLENGTH}
\text{FDWidth} = \text{FDWidth} + \text{BWIDTH}
\text{FDCAPACITY} = \text{FDCAPACITY} + \text{CAPACITY}
\text{FDMAXCAPACITY} = \text{MAX}(\text{FDMAXCAPACITY}, \text{CAPACITY})
\text{FDMAXLENGTH} = \text{MAX}(\text{FDMAXLENGTH}, \text{BLENGTH})
\text{FDMAXWIDTH} = \text{MAX}(\text{FDMAXWIDTH}, \text{BWIDTH})

ENDIF

21 IF (BLENGTH.GE.290..AND.BLENGTH.LE.300..AND.BWIDTH.GE.35.0..AND.
1 \quad \text{BWIDTH.LE.54.0..AND. IAREA.EQ.4..AND. LOADDRAFT.LT.15.2 ..AND.}
2 \quad \text{CAPACITY.GT.99.0..AND. CAPACITY. LT. 10000.0 .AND. LOADDRAFT}
3 \quad \text{GT.LIGHTDRAFT}) THEN

\text{CAPACITY} = \text{CAPACITY} + (\text{LIGHTDRAFT} / (\text{LOADDRAFT} - \text{LIGHTDRAFT})) \times \text{CAPACITY}

\text{GCCOUNT} = \text{GCCOUNT} + 1
\text{GCLength} = \text{GCLength} + \text{BLENGTH}
\text{GCWidth} = \text{GCWidth} + \text{BWIDTH}
\text{GCCAPACITY} = \text{GCCAPACITY} + \text{CAPACITY}
\text{GCMAXCAPACITY} = \text{MAX}(\text{GCMAXCAPACITY}, \text{CAPACITY})
\text{GCMAXLENGTH} = \text{MAX}(\text{GCMAXLENGTH}, \text{BLENGTH})
\text{GCMAXWIDTH} = \text{MAX}(\text{GCMAXWIDTH}, \text{BWIDTH})

ENDIF

22 IF (BLENGTH.GE.290..AND.BLENGTH.LE.300..AND.BWIDTH.GT.54.0..AND.
1 \quad \text{BWIDTH.LT.79 ..AND. IAREA.EQ.4 ..AND. LOADDRAFT.LT.15.2 .AND.}
2 \quad \text{CAPACITY.GT.99.0 ..AND. CAPACITY .LT. 10000.0 .AND. LOADDRAFT}
3 \quad \text{GT.LIGHTDRAFT) THEN}

\text{CAPACITY} = \text{CAPACITY} + (\text{LIGHTDRAFT} / (\text{LOADDRAFT} - \text{LIGHTDRAFT})) \times \text{CAPACITY}

\text{GDCOUNT} = \text{GDCOUNT} + 1
\text{GDLength} = \text{GDLength} + \text{BLENGTH}
\text{GDWidth} = \text{GDWidth} + \text{BWIDTH}
GDCAPACITY=GDCAPACITY+CAPACITY
GDMAXCAPACITY=MAX(GDMAXCAPACITY, CAPACITY)
GDMAXLENGTH=MAX(GDMAXLENGTH, BLENGTH)
GDMAXWIDTH=MAX(GDMAXWIDTH, BWIDTH)

ENDIF

23 IF (BLENGTH.GT.300.0 .AND. BWIDTH.GE.26.0 .AND. BWIDTH.LT.35.0 .AND.
   IAREA.EQ.4 .AND. LOADDRAFT.LT.15.2 .AND.
   CAPACITY.GT.10.0 .AND. CAPACITY.LT.10000.0 .AND. LOADDRAFT
   .GT. 0.0 .AND. LIGHTDRAFT .GT. 0.0) THEN
   CAPACITY=CAPACITY+CAPACITY+(LIGHTDRAFT/(LOADDRAFT-LIGHTDRAFT))*CAPACITY
   HBLENGTH=HBLENGTH+BLENGTH
   HBWIDTH=HBWIDTH+BWIDTH
   HBCAPACITY=HBCAPACITY+CAPACITY
   HBMAXCAPACITY=MAX(HBMAXCAPACITY, CAPACITY)
   HBMAXLENGTH=MAX(HBMAXLENGTH, BLENGTH)
   HBMAXWIDTH=MAX(HBMAXWIDTH, BWIDTH)
   HBCOUNT=HBCOUNT+1
   ENDIF

24 IF (BLENGTH.GT.300.0 .AND. BLENGTH.LT.500.0 .AND. BWIDTH.GE.35.0.
   BWIDTH.LE.54.0 .AND. IAREA.EQ.4 .AND. LOADDRAFT.LT.15.2 .AND.
   CAPACITY.GT.99.0 .AND. CAPACITY.LT.10000.0 .AND. LOADDRAFT
   .GT. 0.0 .AND. LIGHTDRAFT .GT. 0.0) THEN
   CAPACITY=CAPACITY+(LIGHTDRAFT/(LOADDRAFT-LIGHTDRAFT))*CAPACITY
   HCLENGTH=HCLENGTH+BLENGTH
   HCWIDTH=HCWIDTH+BWIDTH
   HCCAPACITY=HCCAPACITY+CAPACITY
   HCMAXCAPACITY=MAX(HCMAXCAPACITY, CAPACITY)
   HCMAXLENGTH=MAX(HCMAXLENGTH, BLENGTH)
   HCMAXWIDTH=MAX(HCMAXWIDTH, BWIDTH)
   HCCOUNT=HCCOUNT+1
   ENDIF

25 IF (BLENGTH.GT.300.0 .AND. BWIDTH.GT.54.0 .AND. IAREA.EQ.4 .AND.
   BWIDTH.LE.79.0 .AND. LOADDRAFT.LT.15.2 .AND.
   CAPACITY.GT.99.0 .AND. CAPACITY.LT.10000.0 ) THEN
   CAPACITY=CAPACITY+(LIGHTDRAFT/(LOADDRAFT-LIGHTDRAFT))*CAPACITY
   HDLENGTH=HDLENGTH+BLENGTH
   HDWIDTH=HDWIDTH+BWIDTH
   HDCALLITY=HDCALLITY+CAPACITY
   HDMAXCAPACITY=MAX(HDMAXCAPACITY, CAPACITY)
   HDMAXLENGTH=MAX(HDMAXLENGTH, BLENGTH)
   HDMAXWIDTH=MAX(HDMAXWIDTH, BWIDTH)
   HDLENGTH=HDLENGTH+BLENGTH
   HDWIDTH=HDWIDTH+BWIDTH
   HDCAPACITY=HDCALLITY+CAPACITY
   HDMAXCAPACITY=MAX(HDMAXCAPACITY, CAPACITY)
   HDMAXLENGTH=MAX(HDMAXLENGTH, BLENGTH)
   HDMAXWIDTH=MAX(HDMAXWIDTH, BWIDTH)
   ENDIF

100 END DO

101 AACAPACITY=AACAPACITY/AACCOUNT
   ABCAPACITY=ABCAPACITY/ACCOUNT
   ACCAPACITY=ACCAPACITY/ACCOUNT
   ADCAPACITY=ADCAPACITY/ACCOUNT
   BACAPACITY=BACAPACITY/BACCOUNT
   BBCAPACITY=BBCAPACITY/BACCOUNT
   BCCAPACITY=BCCAPACITY/BACCOUNT

21
BDCAPACITY = BDCAPACITY / BDCOUNT
CBCAPACITY = CBCAPACITY / CBCOUNT
CCCAPACITY = CCCAPACITY / CCCOUNT
CDCAPACITY = CDCAPACITY / CDCOUNT
DBCAPACITY = DBCAPACITY / DBCOUNT
DCCAPACITY = DCCAPACITY / DDCOUNT
DOCAPACITY = DDCApACITY / DDCOUNT
EACAPACITY = EACAPACITY / EACOUNT
EBCAPACITY = EBCAPACITY / EBCOUNT
ECCAPACITY = ECCAPACITY / ECCOUNT
EDCAPACITY = EDCAPACITY / EDCOUNT
FCCAPACITY = FCCAPACITY / FCCOUNT
FDCAPACITY = FDCAPACITY / FDCOUNT
GCCAPACITY = GCCAPACITY / GCCOUNT
GDCAPACITY = GDCAPACITY / GDCOUNT
HBCAPACITY = HBCAPACITY / HBCOUNT
HCCAPACITY = HCCAPACITY / HCCOUNT
HDCAPACITY = HDCAPACITY / HDCOUNT
AAWIDTH = AAWIDTH / AACOUNT
ABWIDTH = ABWIDTH / ABCOUNT
ACWIDTH = ACWIDTH / ACCOUNT
ADWIDTH = ADWIDTH / ADCOUNT
BWIDTH = BWIDTH / BACOUNT
BBWIDTH = BBWIDTH / BBCOUNT
BCWIDTH = BCWIDTH / BCCOUNT
BDWIDTH = BDWIDTH / BDCOUNT
CWIDTH = CBWIDTH / CBCOUNT
CCWIDTH = CCWIDTH / CCCOUNT
CDWIDTH = CDWIDTH / CDCOUNT
DBWIDTH = DBWIDTH / DBCOUNT
DCWIDTH = DCWIDTH / DDCOUNT
DDWIDTH = DDWIDTH / DDCOUNT
EWIDTH = EWIDTH / EACOUNT
EBWIDTH = EBCAPACITY / EBCOUNT
ECWIDTH = ECCAPACITY / ECCOUNT
EDWIDTH = EDCAPACITY / EDCOUNT
FWIDTH = FCCAPACITY / FCCOUNT
FWIDTH = FDCAPACITY / FDCOUNT
GWIDTH = GCCAPACITY / GCCOUNT
GWIDTH = GDCAPACITY / GDCOUNT
HWIDTH = HBCAPACITY / HBCOUNT
HWIDTH = HCCAPACITY / HCCOUNT
HWIDTH = HDCAPACITY / HDCOUNT
AALENGTH = AALENGTH / AACOUNT
BLENGTH = ABLENGTH / ABCOUNT
ACLENGTH = AACLENGTH / ACCOUNT
ADLENGTH = AADLENGTH / ADCOUNT
BLENGTH = BALENGTH / BACOUNT
BLENGTH = BALENGTH / BACOUNT
<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>VALUE</th>
<th>COUNT</th>
<th>CAPACITY</th>
<th>LENGTH</th>
<th>WIDTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>AACCOUNT</td>
<td>AACAPACITY</td>
<td>AALENGTH</td>
<td>AAWIDTH</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>BACCOUNT</td>
<td>ABCAPACITY</td>
<td>ABLENGTH</td>
<td>ABWIDTH</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>CACCOUNT</td>
<td>ACCAPACITY</td>
<td>ACLENGTH</td>
<td>ACWIDTH</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>DACCOUNT</td>
<td>ADCAPACITY</td>
<td>ADLENGTH</td>
<td>ADWIDTH</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>EACCOUNT</td>
<td>EACAPACITY</td>
<td>EALENGTH</td>
<td>EAWIDTH</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>FACCOUNT</td>
<td>FBCAPACITY</td>
<td>FLENGTH</td>
<td>FWIDTH</td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>GACCOUNT</td>
<td>GCCAPACITY</td>
<td>GLENGTH</td>
<td>GWIDTH</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>HACCOUNT</td>
<td>HCAPACITY</td>
<td>HLENGTH</td>
<td>HWIDTH</td>
<td></td>
</tr>
</tbody>
</table>

**AVERAGE**

```
WRITE(2,*) ***************CATEGORY  AVERAGE VALUES***************
WRITE (2,*) "CATEG.","COUNT","CAPACITY","AVERAGE"
WRITE (2,*) "LENGTH","WIDTH"
WRITE (2,*) "AA",AACOUNT,AACAPACITY,AALENGTH,AAWIDTH
WRITE (2,*) "AB",ACCOUNT,ABCAPACITY,ABLENGTH,ABWIDTH
WRITE (2,*) "AC",ACCOUNT,ACCAPACITY,ACLENGTH,ACWIDTH
WRITE (2,*) "AD",ACCOUNT,ADCAPACITY,ADLENGTH,ADWIDTH
WRITE (2,*) "BA",BACCOUNT,BACAPACITY,BLENGTH,BWIDTH
WRITE (2,*) "BB",BBCOUNT,BBCAPACITY,BLENGTH,BWIDTH
WRITE (2,*) "BC",BBCOUNT,BCCAPACITY,BLENGTH,BCWIDTH
WRITE (2,*) "BD",BDCOUNT,BDCAPACITY,BDLENGTH,BDWIDTH
WRITE (2,*) "CB",CBCOUNT,CBCAPACITY,CLENGTH,CBWIDTH
WRITE (2,*) "CC",CCCOUNT,CCCAPACITY,CLENGTH,CCWIDTH
WRITE (2,*) "CD",CCCOUNT,CDCAPACITY,CDLENGTH,CDWIDTH
WRITE (2,*) "DB",DBCOUNT,DBCAPACITY,DBLENGTH,DBWIDTH
WRITE (2,*) "DC",DCCOUNT,DCCAPACITY,DLENGTH,DCWIDTH
WRITE (2,*) "DD",DDCOUNT,DDCAPACITY,DLENGTH,DDWIDTH
WRITE (2,*) "EA",EACCOUNT,EACAPACITY,EALENGTH,EAWIDTH
WRITE (2,*) "EB",EBCOUNT,EBCAPACITY,EBLENGTH,EBWIDTH
WRITE (2,*) "EC",ECCOUNT,ECCAPACITY,ECLENGTH,ECWIDTH
WRITE (2,*) "ED",EDCOUNT,EDCAPACITY,EDLENGTH,EDWIDTH
WRITE (2,*) "FC",FACCOUNT,FCCAPACITY,FLENGTH,FWIDTH
WRITE (2,*) "FD",FDCOUNT,FDCAPACITY,FDLENGTH,FDWIDTH
WRITE (2,*) "GC",GACCOUNT,GCCAPACITY,GLENGTH,GWIDTH
WRITE (2,*) "GD",GDCOUNT,GDCAPACITY,GDLENGTH,GDWIDTH
WRITE (2,*) "HB",HBACCOUNT,HBCAPACITY,HLENGTH,HWIDTH
WRITE (2,*) "HC",HCCOUNT,HCCAPACITY,HLENGTH,HWIDTH
WRITE (2,*) "HD",HDCOUNT,HDCAPACITY,HDLENGTH,HDWIDTH
```
DO WHILE (.NOT.EOF(1))

READ (1,*) BLENGTH, BWIDTH, CAPACITY, LOADDRAFT, LIGHTDRAFT, IAREA

IF (BLENGTH.GT.10.0 .AND. BLENGTH.LT.100.0 .AND. BWIDTH.GT.10.0 .AND. BWIDTH.LT.26.0 .AND. IAREA.EQ.4 .AND. LOADDRAFT.GT.0.0 .AND. LIGHTDRAFT.GT.0.0)
AASDCAPACITY=AASDCAPACITY+(CAPACITY-AACAPACITY)**2
AASDLENGTH=AASDLENGTH+(BLENGTH-AALENGTH)**2
AASDWIDTH=AASDWIDTH+(BWIDTH-AAWIDTH)**2
ENDIF

IF (BLENGTH.GT.10.0 .AND. BLENGTH.LT.100.0 .AND. BWIDTH.AT.26.0 .AND. IAREA.EQ.4 .AND. LOADDRAFT.LT.15.2 .AND. CAPACITY.GT.10.0 .AND. CAPACITY.LT.4000.0 .AND. LOADDRAFT.GT.0.0 .AND. LIGHTDRAFT.GT.0.0)
ABSDCAPACITY=ABSDCAPACITY+(CAPACITY-ABCAPACITY)**2
ABSDLLENGTH=ABSDLLENGTH+(BLENGTH-ABLENGTH)**2
ABSDWIDTH=ABSDWIDTH+(BWIDTH-ABWIDTH)**2
ENDIF

IF (BLENGTH.GT.10.0 .AND. BLENGTH.LT.100.0 .AND. BWIDTH.LT.35.0 .AND. IAREA.EQ.4 .AND. LOADDRAFT.GT.0.0 .AND. LIGHTDRAFT.GT.0.0)
ACSDCAPACITY=ACSDCAPACITY+(CAPACITY-ACCAPACITY)**2
ACSDLLENGTH=ACSDLLENGTH+(BLENGTH-ACLENGTH)**2
ACSDWIDTH=ACSDWIDTH+(BWIDTH-ACWIDTH)**2
ENDIF

IF (BLENGTH.GT.10.0 .AND. BLENGTH.LT.100.0 .AND. BWIDTH.LT.35.0 .AND. IAREA.EQ.4 .AND. LOADDRAFT.LT.15.2 .AND. CAPACITY.GT.99.0 .AND. CAPACITY.LT.5000.0 .AND. LOADDRAFT.GT.0.0 .AND. LIGHTDRAFT.GT.0.0)
ADSDCAPACITY=ADSDCAPACITY+(CAPACITY-ADCAPACITY)**2
ADSDLLENGTH=ADSDLLENGTH+(BLENGTH-ADLENGTH)**2
ADSDWIDTH=ADSDWIDTH+(BWIDTH-ADWIDTH)**2
ENDIF

IF (BLENGTH.GT.100.0 .AND. BLENGTH.LE.174.0 .AND. BWIDTH.GT.10.0 .AND. BWIDTH.LT.26.0 .AND. IAREA.EQ.4 .AND. LOADDRAFT.LT.15.2 .AND. CAPACITY.GT.10000.0 .AND. LOADDRAFT.GT.0.0 .AND. LIGHTDRAFT.GT.0.0)
BASDCAPACITY=BASDCAPACITY+(CAPACITY-BACAPACITY)**2
BASDLLENGTH=BASDLLENGTH+(BLENGTH-BALENGTH)**2
BASDWIDTH=BASDWIDTH+(BWIDTH-BAWIDTH)**2
ENDIF

IF (BLENGTH.GE.100 .AND. BLENGTH.LE.174 .AND. BWIDTH.GE.26 .AND. BWIDTH.LT.35.0 .AND. IAREA.EQ.4 .AND. LOADDRAFT.LT.15.2 .AND. CAPACITY.GT.99.0 .AND. CAPACITY.LT.10000.0 .AND. LOADDRAFT.GT.0.0 .AND. LIGHTDRAFT.GT.0.0)
24
BBSDCAPACITY = BBSDCAPACITY + (CAPACITY - BBCAPACITY)**2
BBSDLNGTH = BBSDLNGTH + (BLENGTH - BBLENGTH)**2
BBSDWIDTH = BBSDWIDTH + (BWIDTH - BBWIDTH)**2

ENDIF

IF (BLENGTH.GE.100 .. AND. BLENGTH.LE.174 .. AND. BWIDTH.GE.35.0 .. AND.
1 BWIDTH.LE.54.0 .. AND. IAREA.EQ.4 .. AND. LOADDRAFT.LT.15.2 .. AND.
2 CAPACITY.GT.99.0 .. AND. CAPACITY.LT. 10000.0 .. AND. LOADDRAFT
3 .GT. LIGHTDRAFT) THEN

BCSDCAPACITY = BCSDCAPACITY + (CAPACITY - BCCAPACITY)**2
BCSDLNGTH = BCSDLNGTH + (BLENGTH - BCLENGTH)**2
BCSDWIDTH = BCSDWIDTH + (BWIDTH - BCWIDTH)**2

ENDIF

IF (BLENGTH.GE.100 .. AND. BLENGTH.LE.174 .. AND. BWIDTH.GT.54.0 .. AND.
1 BWIDTH.LE.79 .. AND. IAREA.EQ.4 .. AND. LOADDRAFT.LT.15.2 .. AND.
2 CAPACITY.GT.99.0 .. AND. CAPACITY.LT.10000.0 .. AND. LOADDRAFT
3 .GT. LIGHTDRAFT) THEN

BDSDCAPACITY = BDSDCAPACITY + (CAPACITY - BDCAPACITY)**2
BDSDLNGTH = BDSDLNGTH + (BLENGTH - BDLENGTH)**2
BDSDWIDTH = BDSDWIDTH + (BWIDTH - BDWIDTH)**2

ENDIF

IF (BLENGTH.GE.175 .. AND. BLENGTH.LE.194 .. AND. BWIDTH.GE.26 .. AND.
1 BWIDTH.LE.35.0 .. AND. IAREA.EQ.4 .. AND. LOADDRAFT.LT.15.2 .. AND.
2 CAPACITY.GT.99.0 .. AND. CAPACITY.LT.10000.0 .. AND. LOADDRAFT
3 .GT. LIGHTDRAFT) THEN

CBSDCAPACITY = CBSDCAPACITY + (CAPACITY - BCCAPACITY)**2
CBSSDLNGTH = CBSSDLNGTH + (BLENGTH - CCLENGTH)**2
CBSSDWIDTH = CBSSDLNGTH + (BWIDTH - CBWIDTH)**2

ENDIF

IF (BLENGTH.GE.175 .. AND. BLENGTH.LE.194 .. AND. BWIDTH.GE.35.0 .. AND.
1 BWIDTH.LE.79 .. AND. IAREA.EQ.4 .. AND. LOADDRAFT.LT.15.2 .. AND.
2 CAPACITY.GT.99.0 .. AND. CAPACITY.LT.10000.0 .. AND. LOADDRAFT
3 .GT. LIGHTDRAFT) THEN

CCSDCAPACITY = CCSDCAPACITY + (CAPACITY - CCCAPACITY)**2
CCSDLNGTH = CCSDLNGTH + (BLENGTH - CCELNGTH)**2
CCSDWIDTH = CCSDLNGTH + (BWIDTH - CCWIDTH)**2

ENDIF

IF (BLENGTH.GE.175 .. AND. BLENGTH.LE.194 .. AND. BWIDTH.GT.54.0 .. AND.
1 BWIDTH.LE.79 .. AND. IAREA.EQ.4 .. AND. LOADDRAFT.LT.15.2 .. AND.
2 CAPACITY.GT.99.0 .. AND. CAPACITY.LT.10000.0 .. AND. LOADDRAFT
3 .GT. LIGHTDRAFT) THEN

CDSDCAPACITY = CDSDCAPACITY + (CAPACITY - CDCAPACITY)**2
CDSDLNGTH = CDSDLNGTH + (BLENGTH - CDELNGTH)**2
CDSDWIDTH = CDSDLNGTH + (BWIDTH - CDWIDTH)**2

ENDIF

IF (BLENGTH.GE.195 .. AND. BLENGTH.LE.199 .. AND. BWIDTH.GE.26 .. AND.
1 BWIDTH.LE.35.0 .. AND. IAREA.EQ.4 .. AND. LOADDRAFT.LT.15.2 .. AND.
2 CAPACITY.GT.99.0 .. AND. CAPACITY.LT.10000.0 .. AND. LOADDRAFT
3 .GT. LIGHTDRAFT) THEN

DBSDCAPACITY = DBSDCAPACITY + (CAPACITY - DBCAPACITY)**2
DBSDLNGTH = DBSDLNGTH + (BLENGTH - DBLENGTH)**2
DBSDWIDTH = DBSDLNGTH + (BWIDTH - DBWIDTH)**2

ENDIF

25
IF (BLENGTH.GE.195 .. AND. BLENGTH.LE.199 ..
AND. BWIDTH.GE.35.0 .AND. IAREA.EQ.4 .AND. LOADDRAFT.LT.15.2 .AND.
CAPACITY.GT.99.0 .AND. CAPACITY .LT. 10000.0 .AND. LOADDRAFT
.. GT. LIGHTDRAFT) THEN
DCSDCAPACITY=DCSDCAPACITY+(CAPACITY-DCCAPACITY)**2
DCSDLENGTH=DCSDLENGTH+(BLENGTH-DCLENGTH)**2
DCSDWIDTH=DCSDWIDTH+(BWIDTH-DCWIDTH)**2
ENDIF

IF (BLENGTH.GE.195 .. AND. BLENGTH.LE.199 ..
AND. BWIDTH.GT.54.0 .AND. BWIDTH.LE.79 .AND. IAREA.EQ.4 .AND. LOADDRAFT.LT.15.2 .AND.
CAPACITY.GT.99.0 .AND. CAPACITY .LT. 10000.0 .AND. LOADDRAFT
3 .. GT. LIGHTDRAFT) THEN
DDSDCAPACITY=DDSDCAPACITY+(CAPACITY-DDCAPACITY)**2
DDSDLNGTH=DDSDLNGTH+(BLENGTH-DDLENGTH)**2
DDSDWIDTH=DDSDWIDTH+(BWIDTH-DDWIDTH)**2
ENDIF

IF (BLENGTH.GE.200 .. AND. BLENGTH.LE.259 ..
AND. BWIDTH.GE.26 .AND. BWIDTH.LT.35.0 .AND. IAREA.EQ.4 .AND. LOADDRAFT.LT.15.2 .AND.
CAPACITY.GT.99.0 .AND. CAPACITY .LT. 10000.0 .AND. LOADDRAFT
.. GT. LIGHTDRAFT) THEN
EASDCAPACITY=EASDCAPACITY+(CAPACITY-EACAPACITY)**2
EASDLNGTH=EASDLNGTH+(BLENGTH-EALENGTH)**2
EASDWIDTH=EASDWIDTH+(BWIDTH-EAWIDTH)**2
ENDIF

IF (BLENGTH.GE.200 .. AND. BLENGTH.LE.259 ..
AND. BWIDTH.GE.35.0 .AND. BWIDTH.LT.54.0 .AND. IAREA.EQ.4 .AND. LOADDRAFT.LT.15.2 .AND.
CAPACITY.GT.99.0 .AND. CAPACITY .LT. 10000.0 .AND. LOADDRAFT
.. GT. LIGHTDRAFT) THEN
ECSDCAPACITY=ECSDCAPACITY+(CAPACITY-ECCAPACITY)**2
ECSDLNGTH=ECSDLNGTH+(BLENGTH-ECLENGTH)**2
ECSDWIDTH=ECSDWIDTH+(BWIDTH-ECWIDTH)**2
ENDIF

IF (BLENGTH.GE.200 .. AND. BLENGTH.LE.259 ..
AND. BWIDTH.GE.35.0 .AND. BWIDTH.LT.54.0 .AND. IAREA.EQ.4 .AND. LOADDRAFT.LT.15.2 .AND.
CAPACITY.GT.99.0 .AND. CAPACITY .LT. 10000.0 .AND. LOADDRAFT
.. GT. LIGHTDRAFT) THEN
EBSDCAPACITY=EBSDCAPACITY+(CAPACITY-EBCAPACITY)**2
EBSDLNGTH=EBSDLNGTH+(BLENGTH-EBLENGTH)**2
EBSDWIDTH=EBSDWIDTH+(BWIDTH-EBWIDTH)**2
ENDIF

IF (BLENGTH.GE.200 .. AND. BLENGTH.LE.259 ..
AND. BWIDTH.GE.35.0 .AND. BWIDTH.LT.54.0 .AND. IAREA.EQ.4 .AND. LOADDRAFT.LT.15.2 .AND.
CAPACITY.GT.99.0 .AND. CAPACITY .LT. 10000.0 .AND. LOADDRAFT
.. GT. LIGHTDRAFT) THEN
EDSDCAPACITY=EDSDCAPACITY+(CAPACITY-EDCAPACITY)**2
EDSDLNGTH=EDSDLNGTH+(BLENGTH-EDLENGTH)**2
EDSDWIDTH=EDSDWIDTH+(BWIDTH-EDWIDTH)**2
ENDIF

IF (BLENGTH.GE.200 .. AND. BLENGTH.LE.259 ..
AND. BWIDTH.GE.35.0 .AND. BWIDTH.LT.54.0 .AND. IAREA.EQ.4 .AND. LOADDRAFT.LT.15.2 .AND.
CAPACITY.GT.99.0 .AND. CAPACITY .LT. 10000.0 .AND. LOADDRAFT
.. GT. LIGHTDRAFT) THEN
ENDIF
FCSDCAPACITY = FCSDCAPACITY + (CAPACITY - FCCAPACITY) ** 2
FCSDLENGTH = FCSDLENGTH + (BLENGTH - FCLength) ** 2
FCSDWIDTH = FCSDWIDTH + (BWIDTH - FCWIDTH) ** 2

ENDIF

IF (BLENGTH .GE. 260.0 .AND. BLENGTH .LE. 289.0 .AND.
   1 BWIDTH .LE. 79.0 .AND. IAREA .EQ. 4.0 .AND.
   2 CAPACITY .GT. 99.0 .AND. .CAPACITY .LT. 10000.0 .AND.
   3 .GT. LIGHTDRAFT) THEN
   FDSDCAPACITY = FDSDCAPACITY + (CAPACITY - FDCAPACITY) ** 2
   FDSDLNGTH = FDSDLNGTH + (BLENGTH - FDLNGTH) ** 2
   FDSDWIDTH = FDSDWIDTH + (BWIDTH - FWDWIDTH) ** 2
ENDIF

IF (BLENGTH .GE. 290.0 .AND. BLENGTH .LE. 300.0 .AND.
   1 BWIDTH .LE. 54.0 .AND. IAREA .EQ. 4.0 .AND.
   2 CAPACITY .GT. 99.0 .AND. .CAPACITY .LT. 10000.0 .AND.
   3 .GT. LIGHTDRAFT) THEN
   GCSDCAPACITY = GCSDCAPACITY + (CAPACITY - GCCAPACITY) ** 2
   GCSDLNGTH = GCSDLNGTH + (BLENGTH - GCLNGTH) ** 2
   GCSDWIDTH = GCSDWIDTH + (BWIDTH - GCWIDTH) ** 2
ENDIF

IF (BLENGTH .GT. 300.0 .AND. BWIDTH .LE. 26.0 .AND.
   1 BWIDTH .LE. 79.0 .AND. IAREA .EQ. 4.0 .AND.
   2 CAPACITY .GT. 99.0 .AND. .CAPACITY .LT. 10000.0 .AND.
   3 .GT. LIGHTDRAFT) THEN
   HDSDCAPACITY = HDSDCAPACITY + (CAPACITY - HDCAPACITY) ** 2
   HDSDLNGTH = HDSDLNGTH + (BLENGTH - HDLNGTH) ** 2
   HDSDWIDTH = HDSDWIDTH + (BWIDTH - HWDWIDTH) ** 2
ENDIF

END
ENDIF

NOTE: CATEGORIES WITH SMALL COUNTS DO NOT INCLUDE THE TWO STANDARD DEVIATIONS

AAWIDTH=AAWIDTH+2*SQRT(AASDWIDTH/(AACOUNT-1))
ABWIDTH=ABWIDTH+2*SQRT(ABSDWIDTH/(ABCOUNT-1))
ACWIDTH=ACWIDTH+2*SQRT(ACSDWIDTH/(ACCOUNT-1))
ADCAPACITY=ADCAPACITY+2*SQRT(ADSDCAPACITY/(ADCOUNT-1))
BACAPACITY=BACAPACITY+2*SQRT(BASDCAPACITY/(BACOUNT-1))
BCCAPACITY=BCCAPACITY+2*SQRT(BCSDCAPACITY/(BCCOUNT-1))
BDCAPACITY=BDCAPACITY+2*SQRT(BDSDCAPACITY/(BDCOUNT-1))
CCEEDCAPPACITY=CCEEDCAPPACITY+2*SQRT(CCESDCAPACITY/(CCCOUNT-1))
DCCAPACITY=DCCAPACITY+2*SQRT(CDSDCAPACITY/(CDCOUNT-1))
EACAPACITY=EACAPACITY+2*SQRT(EASDCAPACITY/(EACOUNT-1))
EBCAPACITY=EBCAPACITY+2*SQRT(EBSDCAPACITY/(EBCOUNT-1))
ECAPACITY=ECAPACITY+2*SQRT(ECSDCAPACITY/(ECOUNT-1))
EDCAPACITY=EDCAPACITY+2*SQRT(EEDSDCAPACITY/(EDCOUNT-1))
FCCAPACITY=FCCAPACITY+2*SQRT(FCSDCAPACITY/(FCCOUNT-1))
FDCAPACITY=FDCAPACITY+2*SQRT(FDSDCAPACITY/(FDCOUNT-1))
GCCAPACITY=GCCAPACITY+2*SQRT(GCSDCAPACITY/(GCCOUNT-1))
GDCAPACITY=GDCAPACITY+2*SQRT(GDSDCAPACITY/(GDCOUNT-1))
HBCAPACITY=HBCAPACITY+2*SQRT(HBSDCAPACITY/(HBCOUNT-1))
HCCAPACITY=HCCAPACITY+2*SQRT(HCSDCAPACITY/(HCCOUNT-1))
HDCAPACITY=HDCAPACITY+2*SQRT(HDSDCAPACITY/(HDCOUNT-1))
AAWIDTH=AAWIDTH+2*SQRT(AASDWIDTH/(AACOUNT-1))
ABWIDTH=ABWIDTH+2*SQRT(ABSDWIDTH/(ABCOUNT-1))
ACWIDTH = ACWIDTH + 2 * SQRT (ACSDWIDTH / (ACCOUNT - 1))

NEGLECT FOLLOWING LINE SINCE ACCOUNT = 1

ADWIDTH = ADWIDTH + 2 * SQRT (ADSDWIDTH / (ADCOUNT - 1))
BAWIDTH = BAWIDTH + 2 * SQRT (BASDWIDTH / (BACOUNT - 1))
BBWIDTH = BBWIDTH + 2 * SQRT (BBSDWIDTH / (BBCOUNT - 1))
BCWIDTH = BCWIDTH + 2 * SQRT (BCSDWIDTH / (BCCOUNT - 1))
BDWIDTH = BDWIDTH + 2 * SQRT (BDSDWIDTH / (BDCOUNT - 1))
CBWIDTH = CBWIDTH + 2 * SQRT (CBSDWIDTH / (CBCOUNT - 1))
CCWIDTH = CCWIDTH + 2 * SQRT (CCSDWIDTH / (CCCOUNT - 1))

NEGLECT FOLLOWING LINE SINCE ADCOUNT = 1

CDWIDTH = CDWIDTH + 2 * SQRT (CDSDWIDTH / (CDCOUNT - 1))
DBWIDTH = DBWIDTH + 2 * SQRT (DBSDWIDTH / (DBCOUNT - 1))
DCWIDTH = DCWIDTH + 2 * SQRT (DCSDWIDTH / (DCCOUNT - 1))

NEGLECT FOLLOWING LINE SINCE DDCOUNT = 1

DDWIDTH = DDWIDTH + 2 * SQRT (DDSDWIDTH / (DDCOUNT - 1))

NEGLECT FOLLOWING LINE SINCE HBCOUNT = 1

HBWIDTH = HBWIDTH + 2 * SQRT (HBSDWIDTH / (HBCOUNT - 1))
HCWIDTH = HCWIDTH + 2 * SQRT (HCSDWIDTH / (HCCOUNT - 1))
HDWIDTH = HDWIDTH + 2 * SQRT (HDSDWIDTH / (HDCOUNT - 1))

AALENGTH = AALENGTH + 2 * SQRT (AASDLENGTH / (AACOUNT - 1))
ABLENGTH = ABLENGTH + 2 * SQRT (ABSDLENGTH / (ABCOUNT - 1))
ACLENGTH = ACLENGTH + 2 * SQRT (ACSDLENGTH / (ACOUNT - 1))

NEGLECT FOLLOWING LINE SINCE ADCOUNT = 1

ADLENGTH = ADLENGTH + 2 * SQRT (ADSDLENGTH / (ADCOUNT - 1))
BLENGTH = BALENGTH + 2 * SQRT (BASDLENGTH / (BACOUNT - 1))
BLENGTH = BLENGTH + 2 * SQRT (BBSDLENGTH / (BBCOUNT - 1))
CLENGTH = CLENGTH + 2 * SQRT (BCSDLENGTH / (BCCOUNT - 1))
DLENGTH = DLENGTH + 2 * SQRT (BDSDLENGTH / (BDCOUNT - 1))
CLENGTH = CLENGTH + 2 * SQRT (CBSDLENGTH / (CBCOUNT - 1))
CCLENGTH = CCLENGTH + 2 * SQRT (CCSDLENGTH / (CCCOUNT - 1))

NEGLECT FOLLOWING LINE SINCE DDCOUNT = 1

CDLENGTH = CDLENGTH + 2 * SQRT (CDSDLENGTH / (CDCOUNT - 1))
DBLENGTH = DBLENGTH + 2 * SQRT (DBSDLENGTH / (DBCOUNT - 1))
\[ \text{DCLENGTH} = \text{DCLENGTH} + 2 \times \sqrt{\frac{\text{DCSDLENGTH}}{\text{DCOUNT} - 1}} \]

Neglect following line since \text{DCOUNT} = 1

\[ \text{DDLENGTH} = \text{DDLENGTH} + 2 \times \sqrt{\frac{\text{DDSDLENGTH}}{\text{DDCOUNT} - 1}} \]
\[ \text{EALLENGTH} = \text{EALLENGTH} + 2 \times \sqrt{\frac{\text{EASDLENGTH}}{\text{EACOUNT} - 1}} \]
\[ \text{EBLENGTH} = \text{EBLENGTH} + 2 \times \sqrt{\frac{\text{EBSDLLENGTH}}{\text{EBCOUNT} - 1}} \]
\[ \text{ECLENGTH} = \text{ECLENGTH} + 2 \times \sqrt{\frac{\text{ECSDLLENGTH}}{\text{ECCOUNT} - 1}} \]
\[ \text{EDLENGTH} = \text{EDLENGTH} + 2 \times \sqrt{\frac{\text{EDSDLLENGTH}}{\text{EDCOUNT} - 1}} \]
\[ \text{FCLENGTH} = \text{FCLENGTH} + 2 \times \sqrt{\frac{\text{FCSDLLENGTH}}{\text{FCOUNT} - 1}} \]
\[ \text{FDLENGTH} = \text{FDLENGTH} + 2 \times \sqrt{\frac{\text{FDSDLLENGTH}}{\text{FDCOUNT} - 1}} \]
\[ \text{GCLength} = \text{GCLength} + 2 \times \sqrt{\frac{\text{GCSDLLENGTH}}{\text{GCCOUNT} - 1}} \]
\[ \text{GDLENGTH} = \text{GDLENGTH} + 2 \times \sqrt{\frac{\text{GDSLENGTH}}{\text{GDCount} - 1}} \]

Neglect following line since \text{HBCOUNT} = 1

\[ \text{HBLLENGTH} = \text{HBLLENGTH} + 2 \times \sqrt{\frac{\text{HBSLENGTH}}{\text{HBCOUNT} - 1}} \]
\[ \text{HCLength} = \text{HCLength} + 2 \times \sqrt{\frac{\text{HCSLENGTH}}{\text{HCCOUNT} - 1}} \]
\[ \text{HDLLENGTH} = \text{HDLLENGTH} + 2 \times \sqrt{\frac{\text{HDSLENGTH}}{\text{HDCOUNT} - 1}} \]

Find minimum of average plus 2 standard deviations or maximum characteristic value

\[ \text{AACAPACITY} = \min (\text{AACAPACITY, AAMAXCAPACITY}) \]
\[ \text{ABCAPACITY} = \min (\text{ABCAPACITY, ABMAXCAPACITY}) \]
\[ \text{ACCAPACITY} = \min (\text{ACCAPACITY, ACMAXCAPACITY}) \]
\[ \text{ADCAPACITY} = \min (\text{ADCAPACITY, ADMAXCAPACITY}) \]
\[ \text{BACAPACITY} = \min (\text{BACAPACITY, BAMAXCAPACITY}) \]
\[ \text{BBCAPACITY} = \min (\text{BBCAPACITY, BBMAXCAPACITY}) \]
\[ \text{BCCAPACITY} = \min (\text{BCCAPACITY, BCMAXCAPACITY}) \]
\[ \text{BDCAPACITY} = \min (\text{BDCAPACITY, BDMAXCAPACITY}) \]
\[ \text{CBCAPACITY} = \min (\text{CBCAPACITY, CBMAXCAPACITY}) \]
\[ \text{CCCAPACITY} = \min (\text{CCCAPACITY, CCMAXCAPACITY}) \]
\[ \text{CDCAPACITY} = \min (\text{CDCAPACITY, CMDAXCAPACITY}) \]
\[ \text{DBCAPACITY} = \min (\text{DBCAPACITY, DBMAXCAPACITY}) \]
\[ \text{DCCAPACITY} = \min (\text{DCCAPACITY, DCMAXCAPACITY}) \]
\[ \text{DDCAPACITY} = \min (\text{DDCAPACITY, DDMAXCAPACITY}) \]
\[ \text{EACAPACITY} = \min (\text{EACAPACITY, EAMAXCAPACITY}) \]
\[ \text{EBCAPACITY} = \min (\text{EBCAPACITY, EBMAXCAPACITY}) \]
\[ \text{ECAPACITY} = \min (\text{ECAPACITY, ECMAXCAPACITY}) \]
\[ \text{EDCAPACITY} = \min (\text{EDCAPACITY, EDMAXCAPACITY}) \]
\[ \text{FCAPACITY} = \min (\text{FCAPACITY, FCMAXCAPACITY}) \]
\[ \text{FDAPACITY} = \min (\text{FDAPACITY, FDMAXCAPACITY}) \]
\[ \text{GCCAPACITY} = \min (\text{GCCAPACITY, GCMAXCAPACITY}) \]
\[ \text{GDCAPACITY} = \min (\text{GDCAPACITY, GDMAXCAPACITY}) \]
\[ \text{HBCAPACITY} = \min (\text{HBCAPACITY, HBMAXCAPACITY}) \]
\[ \text{HCCAPACITY} = \min (\text{HCCAPACITY, HCMAXCAPACITY}) \]
\[ \text{HDCAPACITY} = \min (\text{HDCAPACITY, HDMAXCAPACITY}) \]

\[ \text{AALENGTH} = \min (\text{AALENGTH, AMAXLENGTH}) \]
\[ \text{ALENGTH} = \min (\text{ALENGTH, AMAXLENGTH}) \]
\[ \text{ACLENGTH} = \min (\text{ACLENGTH, ACMAXLENGTH}) \]
C ADLENGTH=MIN(ADLENGTH,ADMAXLENGTH)

BALENGTH=MIN(BALENGTH,BAMAXLENGTH)
BBLENGTH=MIN(BBLENGTH,BBMAXLENGTH)
BCLength=MIN(BCLength,BCMAXLENGTH)
BDLENGTH=MIN(BDLENGTH,BDMAXLENGTH)

CBLENGTH=MIN(CBLENGTH,CBMAXLENGTH)
CCLENGTH=MIN(CCLENGTH,CCMAXLENGTH)
CDLENGTH=MIN(CDLENGTH,CDMAXLENGTH)

DBLENGTH=MIN(DBLENGTH,DBMAXLENGTH)
DCLength=MIN(DCLENGTH,DCMAXLENGTH)

EALENGTH=MIN(EALENGTH,EAMAXLENGTH)
EBLENGTH=MIN(EBLENGTH,EBMAXLENGTH)
ECLENGTH=MIN(ECLENGTH,ECMAXLENGTH)
EDLENGTH=MIN(EDLENGTH,EDMAXLENGTH)

FCLENGTH=MIN(FCLENGTH,FCMAXLENGTH)
FDLENGTH=MIN(FDLENGTH,FDMAXLENGTH)

GCLENGTH=MIN(GCLENGTH,GCMAXLENGTH)
GDLENGTH=MIN(GDLENGTH,GDMAXLENGTH)

HBLENGTH=MIN(HBLENGTH,HBMAXLENGTH)
HCLENGTH=MIN(HCLENGTH,HCMAXLENGTH)
HDLENGTH=MIN(HDLENGTH,HDMAXLENGTH)

AAWIDTH=MIN(AAWIDTH,AAMAXWIDTH)
ABWIDTH=MIN(ABWIDTH,ABMAXWIDTH)
ACWIDTH=MIN(ACWIDTH,ACMAXWIDTH)

ADWIDTH=MIN(ADWIDTH,ADMAXWIDTH)

BAWIDTH=MIN(BAWIDTH,BAMAXWIDTH)
BBWIDTH=MIN(BBWIDTH,BBMAXWIDTH)
BCWIDTH=MIN(BCWIDTH,BCMAXWIDTH)
BDWIDTH=MIN(BDWIDTH,BDMAXWIDTH)

CBWIDTH=MIN(CBWIDTH,CBMAXWIDTH)
CCWIDTH=MIN(CCWIDTH,CCMAXWIDTH)
CDWIDTH=MIN(CDWIDTH,CDMAXWIDTH)

DBWIDTH=MIN(DBWIDTH,DBMAXWIDTH)
DWIDTH=MIN(DCWIDTH,DCMAXWIDTH)

EAWIDTH=MIN(EAWIDTH,EAMAXWIDTH)
EBWIDTH=MIN(EBWIDTH,EBMAXWIDTH)
ECWIDTH=MIN(ECWIDTH,ECMAXWIDTH)
EDWIDTH=MIN(EDWIDTH,EDMAXWIDTH)

FCWIDTH=MIN(FCWIDTH,FCMAXWIDTH)
FDWIDTH=MIN(FDWIDTH,FDMAXWIDTH)

GCWIDTH=MIN(GCWIDTH,GCMAXWIDTH)
GDWIDTH=MIN(GDWIDTH,GDMAXWIDTH)

HBWIDTH=MIN(HBWIDTH,HBMAXWIDTH)
HCWIDTH=MIN(HCWIDTH,HCMAXWIDTH)

HDWIDTH=MIN(HDWIDTH,HDMAXWIDTH)
WRITE (2, *) "**********AVERAGE PLUS TWO STANDARD DEVIATIONS**********"
WRITE (2, *) "CATEG.", "COUNT", "CAPACITY", "LENGTH", "WIDTH"
Appendix II:

Barge Capacity Results
### Category Average Values

<table>
<thead>
<tr>
<th>Category</th>
<th>Count</th>
<th>Capacity</th>
<th>Length</th>
<th>Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>AA</td>
<td>335.000000</td>
<td>223.129400</td>
<td>71.887470</td>
<td>20.699710</td>
</tr>
<tr>
<td>AB</td>
<td>811.000000</td>
<td>567.839100</td>
<td>62.983400</td>
<td>30.952040</td>
</tr>
<tr>
<td>AC</td>
<td>60.000000</td>
<td>1926.766000</td>
<td>87.573330</td>
<td>40.275000</td>
</tr>
<tr>
<td>AD</td>
<td>1.000000</td>
<td>500.571400</td>
<td>78.000000</td>
<td>55.000000</td>
</tr>
<tr>
<td>BA</td>
<td>52.000000</td>
<td>630.556600</td>
<td>112.594200</td>
<td>23.567300</td>
</tr>
<tr>
<td>BB</td>
<td>1605.000000</td>
<td>666.538300</td>
<td>122.286200</td>
<td>29.468540</td>
</tr>
<tr>
<td>BC</td>
<td>981.000000</td>
<td>1583.328000</td>
<td>142.572900</td>
<td>42.995820</td>
</tr>
<tr>
<td>BD</td>
<td>24.000000</td>
<td>1810.479000</td>
<td>133.825000</td>
<td>55.375000</td>
</tr>
<tr>
<td>CB</td>
<td>1034.000000</td>
<td>1160.919000</td>
<td>175.051900</td>
<td>28.058050</td>
</tr>
<tr>
<td>CC</td>
<td>313.000000</td>
<td>1979.785000</td>
<td>180.190800</td>
<td>42.700960</td>
</tr>
<tr>
<td>CD</td>
<td>1.000000</td>
<td>420.652200</td>
<td>196.100000</td>
<td>54.100000</td>
</tr>
<tr>
<td>DB</td>
<td>491.000000</td>
<td>1979.785000</td>
<td>180.190800</td>
<td>42.700960</td>
</tr>
<tr>
<td>DC</td>
<td>13075.000000</td>
<td>1868.193000</td>
<td>176.114700</td>
<td>26.975800</td>
</tr>
<tr>
<td>DD</td>
<td>1.000000</td>
<td>1257.392000</td>
<td>200.000000</td>
<td>25.000000</td>
</tr>
<tr>
<td>EA</td>
<td>3.000000</td>
<td>1155.556000</td>
<td>215.000000</td>
<td>25.000000</td>
</tr>
<tr>
<td>EB</td>
<td>3.000000</td>
<td>1257.392000</td>
<td>200.000000</td>
<td>25.000000</td>
</tr>
<tr>
<td>EC</td>
<td>6841.000000</td>
<td>2075.766000</td>
<td>202.292600</td>
<td>35.983460</td>
</tr>
<tr>
<td>ED</td>
<td>45.000000</td>
<td>5100.611000</td>
<td>242.677800</td>
<td>71.226670</td>
</tr>
<tr>
<td>FD</td>
<td>353.000000</td>
<td>3643.621000</td>
<td>268.350000</td>
<td>56.183330</td>
</tr>
<tr>
<td>GC</td>
<td>622.000000</td>
<td>3652.683000</td>
<td>191.185600</td>
<td>54.000000</td>
</tr>
<tr>
<td>GD</td>
<td>24.000000</td>
<td>420.652200</td>
<td>188.000000</td>
<td>54.000000</td>
</tr>
<tr>
<td>HB</td>
<td>1.000000</td>
<td>82.500000</td>
<td>91.500000</td>
<td>26.000000</td>
</tr>
<tr>
<td>HC</td>
<td>35.000000</td>
<td>4837.305000</td>
<td>333.020000</td>
<td>52.439990</td>
</tr>
<tr>
<td>HD</td>
<td>2.000000</td>
<td>3504.164000</td>
<td>340.750000</td>
<td>54.550000</td>
</tr>
</tbody>
</table>

**********Average Plus Two Standard Deviations**********

<table>
<thead>
<tr>
<th>Category</th>
<th>Count</th>
<th>Capacity</th>
<th>Length</th>
<th>Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>AA</td>
<td>335.000000</td>
<td>223.129400</td>
<td>71.887470</td>
<td>20.699710</td>
</tr>
<tr>
<td>AB</td>
<td>811.000000</td>
<td>567.839100</td>
<td>62.983400</td>
<td>30.952040</td>
</tr>
<tr>
<td>AC</td>
<td>60.000000</td>
<td>1926.766000</td>
<td>87.573330</td>
<td>40.275000</td>
</tr>
<tr>
<td>AD</td>
<td>1.000000</td>
<td>500.571400</td>
<td>78.000000</td>
<td>55.000000</td>
</tr>
<tr>
<td>BA</td>
<td>52.000000</td>
<td>630.556600</td>
<td>112.594200</td>
<td>23.567300</td>
</tr>
<tr>
<td>BB</td>
<td>1605.000000</td>
<td>666.538300</td>
<td>122.286200</td>
<td>29.468540</td>
</tr>
<tr>
<td>BC</td>
<td>981.000000</td>
<td>1583.328000</td>
<td>142.572900</td>
<td>42.995820</td>
</tr>
<tr>
<td>BD</td>
<td>24.000000</td>
<td>1810.479000</td>
<td>133.825000</td>
<td>55.375000</td>
</tr>
<tr>
<td>CB</td>
<td>1034.000000</td>
<td>1160.919000</td>
<td>175.051900</td>
<td>28.058050</td>
</tr>
<tr>
<td>CC</td>
<td>313.000000</td>
<td>1979.785000</td>
<td>180.190800</td>
<td>42.700960</td>
</tr>
<tr>
<td>CD</td>
<td>1.000000</td>
<td>420.652200</td>
<td>196.100000</td>
<td>54.100000</td>
</tr>
<tr>
<td>DB</td>
<td>491.000000</td>
<td>1979.785000</td>
<td>180.190800</td>
<td>42.700960</td>
</tr>
<tr>
<td>DC</td>
<td>13075.000000</td>
<td>1868.193000</td>
<td>176.114700</td>
<td>26.975800</td>
</tr>
<tr>
<td>DD</td>
<td>1.000000</td>
<td>1257.392000</td>
<td>200.000000</td>
<td>25.000000</td>
</tr>
<tr>
<td>EA</td>
<td>3.000000</td>
<td>1155.556000</td>
<td>215.000000</td>
<td>25.000000</td>
</tr>
<tr>
<td>EB</td>
<td>3.000000</td>
<td>1257.392000</td>
<td>200.000000</td>
<td>25.000000</td>
</tr>
<tr>
<td>EC</td>
<td>6841.000000</td>
<td>2075.766000</td>
<td>202.292600</td>
<td>35.983460</td>
</tr>
<tr>
<td>ED</td>
<td>45.000000</td>
<td>5100.611000</td>
<td>242.677800</td>
<td>71.226670</td>
</tr>
<tr>
<td>FD</td>
<td>353.000000</td>
<td>3643.621000</td>
<td>268.350000</td>
<td>56.183330</td>
</tr>
<tr>
<td>GC</td>
<td>622.000000</td>
<td>3652.683000</td>
<td>191.185600</td>
<td>54.000000</td>
</tr>
<tr>
<td>GD</td>
<td>24.000000</td>
<td>420.652200</td>
<td>188.000000</td>
<td>54.000000</td>
</tr>
<tr>
<td>HB</td>
<td>1.000000</td>
<td>82.500000</td>
<td>91.500000</td>
<td>26.000000</td>
</tr>
<tr>
<td>HC</td>
<td>35.000000</td>
<td>4837.305000</td>
<td>333.020000</td>
<td>52.439990</td>
</tr>
<tr>
<td>HD</td>
<td>2.000000</td>
<td>3504.164000</td>
<td>340.750000</td>
<td>54.550000</td>
</tr>
</tbody>
</table>
Appendix III:

Computer Program for Assigning the Number of Barges to Flotilla Columns and Rows
DECLARE SUB CATEGORY ()
DECLARE SUB CLASSIFY ()
DECLARE SUB CLASSIFY2 ()
DECLARE SUB DEVIATION ()
DECLARE SUB DIVBY1 ()
DECLARE SUB DIVBY2 ()
DECLARE SUB DIVBY3 ()
DECLARE SUB DIVBY4 ()
DECLARE SUB DIVBY5 ()
DECLARE SUB DIVBY6 ()
DECLARE SUB DIVBY7 ()
DECLARE SUB LABEL ()
DECLARE SUB MESSAGE ()
DECLARE SUB RESULTS ()

REM********************************************************************
AVGBARGE.BAS
REM*
REM*
REM*
REM*
REM*
REM*
REM*
REM*
REM*
REM*

Program to calculate the average number of barges per flotilla column and row in each of 32 barge
dimension categories as specified by the U.S. Army Corps of Engineers

Written by: Jeff Griffin, June 1994

REM********************************************************************

REM COMMON SHARED FILEAS, FILECS, RIVERS, MILE
COMMON SHARED H%, I%, J%, K%, L%, M%, N%, O%
COMMON SHARED FL(), FW(), NOC(), NB(), NBCL(), NBRW()
COMMON SHARED FWAVG(), FLAVG(), NUM
COMMON SHARED SUMNOC(), SUMNBRWxNOC(), SUMNBCLxNOC()
COMMON SHARED CATAVGC(), CATAVGR(), MAXC(), MAXR()
COMMON SHARED DEVNUMR(), STDR(), STDR2(), NUMBR
COMMON SHARED DEVNUMC(), STDC(), STDC2()
DIM FL(3000), FW(3000), NOC(3000), NB(3000), NBCL(3000), NBRW(3000)
DIM FWAVG(3000), FLAVG(3000)
DIM SUMNOC(32), SUMNBRWxNOC(32), SUMNBCLxNOC(32)
DIM CATAVGC(32), CATAVGR(32), MAXC(32), MAXR(32)
DIM DEVNUMR(32), STDR(32), STDR2(32)
DIM DEVNUMC(32), STDC(32), STDC2(32)

CLS
SCREEN 12

REM

REM******************************************************************************

REM*
REM* INITIALIZE WEIGHTED AVERAGE SUM VARIABLES
REM*
REM******************************************************************************

REM FOR H% = 1 TO 32
SUMNOC(H%) = 0
SUMNBRWxNOC(H%) = 0
SUMNBCLxNOC(H%) = 0
MAXC(H%) = 0
MAXR(H%) = 0
NEXT H%

REM

REM******************************************************************************
FILE INPUT/OUTPUT SPECIFICATION

COLOR 10
LOCATE 4, 15: PRINT "AVERAGE NUMBER OF BARGES IN FLOTILLA COLUMN PROGRAM"
COLOR 15
LINE (70, 80)-(580, 200), 9, B
LOCATE 7, 14: INPUT "What is the name of the file to be processed";
FILEIS
OPEN FILEIS$ FOR INPUT AS ~1
LOCATE 9, 14: INPUT "What is the name of the file to be output";
FILEOS
OPEN FILEOS$ FOR OUTPUT AS ~2
LOCATE 11, 14: INPUT "What is the river and marker designation";
RIVERS, MILE
REM
REM******************************************************
REM MODIFICATION OF NUMBER OF BARGES IN FLOTILLA TO ADJUST
REM FOR NUMBER OF BARGES EXPECTED IN COLUMN AND ROW
REM
REM********************************************************
REM
K% = J% - 1
I% = 1
DO WHILE I% <= K%
REM CHECK FLOTILLA WIDTH TO BE WITHIN A REASONABLE RANGE
REM IF FW(I%) >= 20 AND FW(I%) <= 245 THEN
REM CHECK FLOTILLA WIDTH TO BE LESS THAN 50 FEET
REM IF FW(I%) < 50 THEN
CALL DIVBY1
END IF
REM
REM CHECK FLOTILLA WIDTH TO BE 50 FEET
REM IF FW(I%) = 50 THEN

IF NB(I%) > 5 THEN
  CALL DIVBY2
ELSE
  CALL DIVBY1
END IF
END IF

REM CHECK FLOTILLA WIDTH TO BE BETWEEN 50 AND 60 FEET, EXCLUSIVE
REM
IF FW(I%) > 50 AND FW(I%) < 60 THEN
  IF FL(I%) < 100 AND NB(I%) > 1 THEN
    CALL DIVBY2
  ELSE
    CALL DIVBY1
  END IF
END IF

REM CHECK FLOTILLA WIDTH TO BE 60 FEET
REM
IF FW(I%) = 60 THEN
  IF FL(I%) > 500 AND NB(I%) <= 3 THEN
    CALL DIVBY1
  ELSE
    CALL DIVBY2
  END IF
END IF

REM CHECK FLOTILLA WIDTH TO BE BETWEEN 60 AND 70 FEET, EXCLUSIVE
REM
IF FW(I%) > 60 AND FW(I%) < 70 THEN
  IF FL(I%) >= 600 AND NB(I%) <= 5 THEN
    CALL DIVBY1
  ELSE
    CALL DIVBY2
  END IF
END IF

REM CHECK FLOTILLA WIDTH TO BE 70 FEET
REM
IF FW(I%) = 70 THEN
  CALL DIVBY2
END IF

REM CHECK FLOTILLA WIDTH TO BE BETWEEN 70 AND 85 FEET, EXCLUSIVE
REM
IF FW(I%) > 70 AND FW(I%) < 85 THEN
  IF NB(I%) >= 4 THEN
    CALL DIVBY2
  ELSE
    CALL DIVBY1
  END IF
END IF

REM CHECK FLOTILLA WIDTH TO BE BETWEEN 85 AND EXCLUSIVE 105 FEET
REM
IF FW(I%) >= 85 AND FW(I%) < 105 THEN
  CALL DIVBY2
END IF

REM CHECK FLOTILLA WIDTH TO BE 105 FEET
REM
IF FW(I%) = 105 THEN
  IF NB(I%) <= 6 THEN
    CALL DIVBY2
  ELSE
    CALL DIVBY1
  END IF

REM
CALL DIVBY3
END IF
END IF

REM
REM CHECK FLOTILLA WIDTH TO BE BETWEEN EXCLUSIVE 105 AND 110 FEET
REM
IF FW(I%) > 105 AND FW(I%) <= 110 THEN
CALL DIVBY2
END IF
REM
REM CHECK FLOTILLA WIDTH TO BE BETWEEN 110 AND 120 FEET, EXCLUSIVE
REM
IF FW(I%) > 110 AND FW(I%) < 120 THEN
IF NB(I%) > 21 THEN
CALL DIVBY3
ELSE
CALL DIVBY2
END IF
END IF
REM
REM CHECK FLOTILLA WIDTH TO BE BETWEEN 120 AND 122 FEET, INCLUSIVE
REM
IF FW(I%) >= 120 AND FW(I%) <= 122 THEN
CALL DIVBY4
END IF
REM
REM CHECK FLOTILLA WIDTH TO BE BETWEEN 122 AND 140 FEET, EXCLUSIVE
REM
IF FW(I%) > 122 AND FW(I%) < 140 THEN
CALL DIVBY3
END IF
REM
REM CHECK FLOTILLA WIDTH TO BE 140 FEET
REM
IF FW(I%) = 140 THEN
CALL DIVBY4
END IF
REM
REM CHECK FLOTILLA WIDTH TO BE BETWEEN 140 AND INCLUSIVE 165 FEET
REM
IF FW(I%) > 140 AND FW(I%) <= 165 THEN
CALL DIVBY3
END IF
REM
REM CHECK FLOTILLA WIDTH TO BE BETWEEN 165 AND 175 FEET, EXCLUSIVE
REM
IF FW(I%) > 165 AND FW(I%) < 175 THEN
CALL DIVBY4
END IF
REM
REM CHECK FLOTILLA WIDTH TO BE 175 FEET
REM
IF FW(I%) = 175 THEN
IF NB(I%) <= 10 THEN
CALL DIVBY4
ELSE
CALL DIVBY5
END IF
END IF
REM
REM CHECK FLOTILLA WIDTH TO BE BETWEEN 175 AND INCLUSIVE 180 FEET
REM
IF FW(I%) > 175 AND FW(I%) <= 180 THEN
IF NB(I%) <= 10 THEN
CALL DIVBY2
END IF
END IF
END IF
IF NB(I%) > 10 AND NB(I%) < 19 THEN
   CALL DIVBY4
END IF
END IF

REM
REM CHECK FLOTILLA WIDTH TO BE BETWEEN 180 AND 200 FEET, EXCLUSIVE
REM
IF FW(I%) > 180 AND FW(I%) < 200 THEN
   IF NB(I%) < 11 THEN
      CALL DIVBY4
   ELSE
      CALL DIVBY5
   END IF
END IF
REM
REM CHECK FLOTILLA WIDTH TO BE BETWEEN INCLUSIVE 200 AND 233 FEET
REM
IF FW(I%) >= 200 AND FW(I%) < 233 THEN
   IF FW(I%) = 210 AND NB(I%) > 20 THEN
      CALL DIVBY6
   ELSE
      CALL DIVBY4
   END IF
END IF
REM
REM CHECK FLOTILLA WIDTH TO BE BETWEEN 233 AND 290 FEET INCLUSIVE
REM
IF FW(I%) >= 233 AND FW(I%) <= 290 THEN
   IF FW(I%) = 245 AND NB(I%) > 24 THEN
      CALL DIVBY7
   ELSE
      CALL DIVBY5
   END IF
END IF
REM
REM CHECK FLOTILLA WIDTH TO BE BETWEEN 290 AND INCLUSIVE 330 FEET
REM
IF FW(I%) > 290 AND FW(I%) <= 330 THEN
   CALL DIVBY6
END IF
REM
REM CHECK FLOTILLA WIDTH TO BE GREATER THAN 330 FEET
REM
IF FW(I%) > 330 THEN
   CALL DIVBY7
END IF
REM
IF NBCL(I%) < 1 THEN NBCL(I%) = 1
REM
* CALCULATE THE AVERAGE BARGE LENGTH IN THE FLOTILLA COLUMN
* 
* FLAVG(I%) = FL(I%) / NBCL(I%)
REM
*
* DETERMINE THE APPROPRIATE BARGE CATEGORY FOR THE FLOTILLA
* BASED UPON THE AVERAGE BARGE LENGTH CALCULATED ABOVE
*
* CALL CLASSIFY
*
SUM THE NUMBER OF BARGES PER ROW AND THE NUMBER OF
* OCCURRENCES BASED ON THE CATEGORY ASSIGNED ABOVE
*
CALL CATEGORY
*
END IF
I% = I% + 1
LOOP
*
CALCULATE THE WEIGHTED AVERAGE
*
FOR L% = 1 TO 32
IF SUMNBRxNOC(L%) = 0 THEN
CATAVGR(L%) = 0
ELSE
CATAVGR(L%) = SUMNBRxNOC(L%) / SUMNOC(L%)
END IF
IF SUMNBCLxNOC(L%) = 0 THEN
CATAVGC(L%) = 0
ELSE
CATAVGC(L%) = SUMNBCLxNOC(L%) / SUMNOC(L%)
END IF
NEXT L%
*
CALCULATE THE STANDARD DEVIATION DENOMINATOR
*
FOR N% = 1 TO K%
call classify2
call deviation
NEXT N%
REM********************************************************************
REM* CALCULATE THE STANDARD DEVIATION FOR EACH OF THE 32 CATEGORIES *
REM*
REM********************************************************************

REM FOR 0% = 1 TO 32
IF SUMNOC(0%) <= 1 THEN
  STDR(0%) = 0
  STDC(0%) = 0
ELSE
  STDR(0%) = (DEVNUMR(0%) / (SUMNOC(0%) - 1)) ^ .5
  STDC(0%) = (DEVNUMC(0%) / (SUMNOC(0%) - 1)) ^ .5
END IF
STDR2(0%) = 2 * STDR(0%)
STDC2(0%) = 2 * STDC(0%)
NEXT %

REM********************************************************************
REM* PRINT THE RESULTS TO THE SPECIFIED FILE *
REM*
REM********************************************************************

REM CALL RESULTS
REM END
STOP

SUB CATEGORY
SELECT CASE NUM
CASE 1
  SUMNOC(1) = SUMNOC(1) + NOC(I%)  
  SUMNBRxNOC(1) = SUMNBRxNOC(1) + (NBRW(I%) * NOC(I%))  
  SUMNBCLxNOC(1) = SUMNBCLxNOC(1) + (NBCL(I%) * NOC(I%))  
  IF NBCL(I%) > MAXC(1) THEN  
    MAXC(1) = NBCL(I%)  
  ELSE  
    MAXC(1) = MAXC(1)  
  END IF  
  IF NBRW(I%) > MAXR(1) THEN  
    MAXR(1) = NBRW(I%)  
  ELSE  
    MAXR(1) = MAXR(1)  
  END IF
CASE 2
  SUMNOC(2) = SUMNOC(2) + NOC(I%)  
  SUMNBRxNOC(2) = SUMNBRxNOC(2) + (NBRW(I%) * NOC(I%))  
  SUMNBCLxNOC(2) = SUMNBCLxNOC(2) + (NBCL(I%) * NOC(I%))  
  IF NBCL(I%) > MAXC(2) THEN  
    MAXC(2) = NBCL(I%)  
  ELSE  
    MAXC(2) = MAXC(2)  
  END IF  
  IF NBRW(I%) > MAXR(2) THEN  
    MAXR(2) = NBRW(I%)  
  ELSE  
    MAXR(2) = MAXR(2)  
  END IF

42
CASE 3
\[ \text{SUMNOC}(3) = \text{SUMNOC}(3) + \text{NOC}(I) \]
\[ \text{SUMNBRWxNOC}(3) = \text{SUMNBRWxNOC}(3) + (\text{NBRW}(I) \times \text{NOC}(I)) \]
\[ \text{SUMNBCLxNOC}(3) = \text{SUMNBCLxNOC}(3) + (\text{NBCL}(I) \times \text{NOC}(I)) \]
IF \( \text{NBCL}(I) > \text{MAXC}(3) \) THEN
  \[ \text{MAXC}(3) = \text{NBCL}(I) \]
ELSE
  \[ \text{MAXC}(3) = \text{MAXC}(3) \]
END IF
IF \( \text{NBRW}(I) > \text{MAXR}(3) \) THEN
  \[ \text{MAXR}(3) = \text{NBRW}(I) \]
ELSE
  \[ \text{MAXR}(3) = \text{MAXR}(3) \]
END IF

CASE 4
\[ \text{SUMNOC}(4) = \text{SUMNOC}(4) + \text{NOC}(I) \]
\[ \text{SUMNBRWxNOC}(4) = \text{SUMNBRWxNOC}(4) + (\text{NBRW}(I) \times \text{NOC}(I)) \]
\[ \text{SUMNBCLxNOC}(4) = \text{SUMNBCLxNOC}(4) + (\text{NBCL}(I) \times \text{NOC}(I)) \]
IF \( \text{NBCL}(I) > \text{MAXC}(4) \) THEN
  \[ \text{MAXC}(4) = \text{NBCL}(I) \]
ELSE
  \[ \text{MAXC}(4) = \text{MAXC}(4) \]
END IF
IF \( \text{NBRW}(I) > \text{MAXR}(4) \) THEN
  \[ \text{MAXR}(4) = \text{NBRW}(I) \]
ELSE
  \[ \text{MAXR}(4) = \text{MAXR}(4) \]
END IF

CASE 5
\[ \text{SUMNOC}(5) = \text{SUMNOC}(5) + \text{NOC}(I) \]
\[ \text{SUMNBRWxNOC}(5) = \text{SUMNBRWxNOC}(5) + (\text{NBRW}(I) \times \text{NOC}(I)) \]
\[ \text{SUMNBCLxNOC}(5) = \text{SUMNBCLxNOC}(5) + (\text{NBCL}(I) \times \text{NOC}(I)) \]
IF \( \text{NBCL}(I) > \text{MAXC}(5) \) THEN
  \[ \text{MAXC}(5) = \text{NBCL}(I) \]
ELSE
  \[ \text{MAXC}(5) = \text{MAXC}(5) \]
END IF
IF \( \text{NBRW}(I) > \text{MAXR}(5) \) THEN
  \[ \text{MAXR}(5) = \text{NBRW}(I) \]
ELSE
  \[ \text{MAXR}(5) = \text{MAXR}(5) \]
END IF

CASE 6
\[ \text{SUMNOC}(6) = \text{SUMNOC}(6) + \text{NOC}(I) \]
\[ \text{SUMNBRWxNOC}(6) = \text{SUMNBRWxNOC}(6) + (\text{NBRW}(I) \times \text{NOC}(I)) \]
\[ \text{SUMNBCLxNOC}(6) = \text{SUMNBCLxNOC}(6) + (\text{NBCL}(I) \times \text{NOC}(I)) \]
IF \( \text{NBCL}(I) > \text{MAXC}(6) \) THEN
  \[ \text{MAXC}(6) = \text{NBCL}(I) \]
ELSE
  \[ \text{MAXC}(6) = \text{MAXC}(6) \]
END IF
IF \( \text{NBRW}(I) > \text{MAXR}(6) \) THEN
  \[ \text{MAXR}(6) = \text{NBRW}(I) \]
ELSE
  \[ \text{MAXR}(6) = \text{MAXR}(6) \]
END IF

CASE 7
\[ \text{SUMNOC}(7) = \text{SUMNOC}(7) + \text{NOC}(I) \]
\[ \text{SUMNBRWxNOC}(7) = \text{SUMNBRWxNOC}(7) + (\text{NBRW}(I) \times \text{NOC}(I)) \]
\[ \text{SUMNBCLxNOC}(7) = \text{SUMNBCLxNOC}(7) + (\text{NBCL}(I) \times \text{NOC}(I)) \]
IF \( \text{NBCL}(I) > \text{MAXC}(7) \) THEN
  \[ \text{MAXC}(7) = \text{NBCL}(I) \]
ELSE
  \[ \text{MAXC}(7) = \text{MAXC}(7) \]
END IF
IF NBRW(I%) > MAXR(7) THEN
MAXR(7) = NBRW(I%)
ELSE
MAXR(7) = MAXR(7)
END IF

CASE 8
SUMNOC(8) = SUMNOC(8) + NOC(I%)
SUMNBRWxNOC(8) = SUMNBRWxNOC(8) + (NBRW(I%) * NOC(I%))
SUMNBCLxNOC(8) = SUMNBCLxNOC(8) + (NBCL(I%) * NOC(I%))
IF NBCL(I%) > MAXC(8) THEN
MAXC(8) = NBCL(I%)
ELSE
MAXC(8) = MAXC(8)
END IF
IF NBRW(I%) > MAXR(8) THEN
MAXR(8) = NBRW(I%)
ELSE
MAXR(8) = MAXR(8)
END IF

CASE 9
SUMNOC(9) = SUMNOC(9) + NOC(I%)
SUMNBRWxNOC(9) = SUMNBRWxNOC(9) + (NBRW(I%) * NOC(I%))
SUMNBCLxNOC(9) = SUMNBCLxNOC(9) + (NBCL(I%) * NOC(I%))
IF NBCL(I%) > MAXC(9) THEN
MAXC(9) = NBCL(I%)
ELSE
MAXC(9) = MAXC(9)
END IF
IF NBRW(I%) > MAXR(9) THEN
MAXR(9) = NBRW(I%)
ELSE
MAXR(9) = MAXR(9)
END IF

CASE 10
SUMNOC(10) = SUMNOC(10) + NOC(I%)
SUMNBRWxNOC(10) = SUMNBRWxNOC(10) + (NBRW(I%) * NOC(I%))
SUMNBCLxNOC(10) = SUMNBCLxNOC(10) + (NBCL(I%) * NOC(I%))
IF NBCL(I%) > MAXC(10) THEN
MAXC(10) = NBCL(I%)
ELSE
MAXC(10) = MAXC(10)
END IF
IF NBRW(I%) > MAXR(10) THEN
MAXR(10) = NBRW(I%)
ELSE
MAXR(10) = MAXR(10)
END IF

CASE 11
SUMNOC(11) = SUMNOC(11) + NOC(I%)
SUMNBRWxNOC(11) = SUMNBRWxNOC(11) + (NBRW(I%) * NOC(I%))
SUMNBCLxNOC(11) = SUMNBCLxNOC(11) + (NBCL(I%) * NOC(I%))
IF NBCL(I%) > MAXC(11) THEN
MAXC(11) = NBCL(I%)
ELSE
MAXC(11) = MAXC(11)
END IF
IF NBRW(I%) > MAXR(11) THEN
MAXR(11) = NBRW(I%)
ELSE
MAXR(11) = MAXR(11)
END IF

CASE 12
SUMNOC(12) = SUMNOC(12) + NOC(I%)
SUMNBRWxNOC(12) = SUMNBRWxNOC(12) + (NBRW(I%) * NOC(I%))
SUMNBCLxNOC(12) = SUMNBCLxNOC(12) + (NBCL(I%) * NOC(I%))
IF \text{NBCL}(I%) > \text{MAXC}(12) \text{ THEN}
\text{MAXC}(12) = \text{NBCL}(I%)
ELSE
\text{MAXC}(12) = \text{MAXC}(12)
END IF

IF \text{NBRW}(I%) > \text{MAXR}(12) \text{ THEN}
\text{MAXR}(12) = \text{NBRW}(I%)
ELSE
\text{MAXR}(12) = \text{MAXR}(12)
END IF

\text{CASE 13}
\text{SUMNOC}(13) = \text{SUMNOC}(13) + \text{NOC}(I%)
\text{SUMNBRWxNOC}(13) = \text{SUMNBRWxNOC}(13) + (\text{NBRW}(I%) \times \text{NOC}(I%))
\text{SUMNBCLxNOC}(13) = \text{SUMNBCLxNOC}(13) + (\text{NBCL}(I%) \times \text{NOC}(I%))
IF \text{NBCL}(I%) > \text{MAXC}(13) \text{ THEN}
\text{MAXC}(13) = \text{NBCL}(I%)
ELSE
\text{MAXC}(13) = \text{MAXC}(13)
END IF

IF \text{NBRW}(I%) > \text{MAXR}(13) \text{ THEN}
\text{MAXR}(13) = \text{NBRW}(I%)
ELSE
\text{MAXR}(13) = \text{MAXR}(13)
END IF

\text{CASE 14}
\text{SUMNOC}(14) = \text{SUMNOC}(14) + \text{NOC}(I%)
\text{SUMNBRWxNOC}(14) = \text{SUMNBRWxNOC}(14) + (\text{NBRW}(I%) \times \text{NOC}(I%))
\text{SUMNBCLxNOC}(14) = \text{SUMNBCLxNOC}(14) + (\text{NBCL}(I%) \times \text{NOC}(I%))
IF \text{NBCL}(I%) > \text{MAXC}(14) \text{ THEN}
\text{MAXC}(14) = \text{NBCL}(I%)
ELSE
\text{MAXC}(14) = \text{MAXC}(14)
END IF

IF \text{NBRW}(I%) > \text{MAXR}(14) \text{ THEN}
\text{MAXR}(14) = \text{NBRW}(I%)
ELSE
\text{MAXR}(14) = \text{MAXR}(14)
END IF

\text{CASE 15}
\text{SUMNOC}(15) = \text{SUMNOC}(15) + \text{NOC}(I%)
\text{SUMNBRWxNOC}(15) = \text{SUMNBRWxNOC}(15) + (\text{NBRW}(I%) \times \text{NOC}(I%))
\text{SUMNBCLxNOC}(15) = \text{SUMNBCLxNOC}(15) + (\text{NBCL}(I%) \times \text{NOC}(I%))
IF \text{NBCL}(I%) > \text{MAXC}(15) \text{ THEN}
\text{MAXC}(15) = \text{NBCL}(I%)
ELSE
\text{MAXC}(15) = \text{MAXC}(15)
END IF

IF \text{NBRW}(I%) > \text{MAXR}(15) \text{ THEN}
\text{MAXR}(15) = \text{NBRW}(I%)
ELSE
\text{MAXR}(15) = \text{MAXR}(15)
END IF

\text{CASE 16}
\text{SUMNOC}(16) = \text{SUMNOC}(16) + \text{NOC}(I%)
\text{SUMNBRWxNOC}(16) = \text{SUMNBRWxNOC}(16) + (\text{NBRW}(I%) \times \text{NOC}(I%))
\text{SUMNBCLxNOC}(16) = \text{SUMNBCLxNOC}(16) + (\text{NBCL}(I%) \times \text{NOC}(I%))
IF \text{NBCL}(I%) > \text{MAXC}(16) \text{ THEN}
\text{MAXC}(16) = \text{NBCL}(I%)
ELSE
\text{MAXC}(16) = \text{MAXC}(16)
END IF

IF \text{NBRW}(I%) > \text{MAXR}(16) \text{ THEN}
\text{MAXR}(16) = \text{NBRW}(I%)
ELSE
\text{MAXR}(16) = \text{MAXR}(16)
END IF
END IF

CASE 17
\[
\text{SUMNOC}(17) = \text{SUMNOC}(17) + \text{NOC}(I%)
\]
\[
\text{SUMNBRWxNOC}(17) = \text{SUMNBRWxNOC}(17) + (\text{NBRW}(I%) \times \text{NOC}(I%))
\]
\[
\text{SUMNBCLxNOC}(17) = \text{SUMNBCLxNOC}(17) + (\text{NBCL}(I%) \times \text{NOC}(I%))
\]
IF \text{NBCL}(I%) > \text{MAXC}(17) THEN
\[
\text{MAXC}(17) = \text{NBCL}(I%)
\]
ELSE
\[
\text{MAXC}(17) = \text{MAXC}(17)
\]
END IF
IF \text{NBRW}(I%) > \text{MAXR}(17) THEN
\[
\text{MAXR}(17) = \text{NBRW}(I%)
\]
ELSE
\[
\text{MAXR}(17) = \text{MAXR}(17)
\]
END IF

CASE 18
\[
\text{SUMNOC}(18) = \text{SUMNOC}(18) + \text{NOC}(I%)
\]
\[
\text{SUMNBRWxNOC}(18) = \text{SUMNBRWxNOC}(18) + (\text{NBRW}(I%) \times \text{NOC}(I%))
\]
\[
\text{SUMNBCLxNOC}(18) = \text{SUMNBCLxNOC}(18) + (\text{NBCL}(I%) \times \text{NOC}(I%))
\]
IF \text{NBCL}(I%) > \text{MAXC}(18) THEN
\[
\text{MAXC}(18) = \text{NBCL}(I%)
\]
ELSE
\[
\text{MAXC}(18) = \text{MAXC}(18)
\]
END IF
IF \text{NBRW}(I%) > \text{MAXR}(18) THEN
\[
\text{MAXR}(18) = \text{NBRW}(I%)
\]
ELSE
\[
\text{MAXR}(18) = \text{MAXR}(18)
\]
END IF

CASE 19
\[
\text{SUMNOC}(19) = \text{SUMNOC}(19) + \text{NOC}(I%)
\]
\[
\text{SUMNBRWxNOC}(19) = \text{SUMNBRWxNOC}(19) + (\text{NBRW}(I%) \times \text{NOC}(I%))
\]
\[
\text{SUMNBCLxNOC}(19) = \text{SUMNBCLxNOC}(19) + (\text{NBCL}(I%) \times \text{NOC}(I%))
\]
IF \text{NBCL}(I%) > \text{MAXC}(19) THEN
\[
\text{MAXC}(19) = \text{NBCL}(I%)
\]
ELSE
\[
\text{MAXC}(19) = \text{MAXC}(19)
\]
END IF
IF \text{NBRW}(I%) > \text{MAXR}(19) THEN
\[
\text{MAXR}(19) = \text{NBRW}(I%)
\]
ELSE
\[
\text{MAXR}(19) = \text{MAXR}(19)
\]
END IF

CASE 20
\[
\text{SUMNOC}(20) = \text{SUMNOC}(20) + \text{NOC}(I%)
\]
\[
\text{SUMNBRWxNOC}(20) = \text{SUMNBRWxNOC}(20) + (\text{NBRW}(I%) \times \text{NOC}(I%))
\]
\[
\text{SUMNBCLxNOC}(20) = \text{SUMNBCLxNOC}(20) + (\text{NBCL}(I%) \times \text{NOC}(I%))
\]
IF \text{NBCL}(I%) > \text{MAXC}(20) THEN
\[
\text{MAXC}(20) = \text{NBCL}(I%)
\]
ELSE
\[
\text{MAXC}(20) = \text{MAXC}(20)
\]
END IF
IF \text{NBRW}(I%) > \text{MAXR}(20) THEN
\[
\text{MAXR}(20) = \text{NBRW}(I%)
\]
ELSE
\[
\text{MAXR}(20) = \text{MAXR}(20)
\]
END IF

CASE 21
\[
\text{SUMNOC}(21) = \text{SUMNOC}(21) + \text{NOC}(I%)
\]
\[
\text{SUMNBRWxNOC}(21) = \text{SUMNBRWxNOC}(21) + (\text{NBRW}(I%) \times \text{NOC}(I%))
\]
\[
\text{SUMNBCLxNOC}(21) = \text{SUMNBCLxNOC}(21) + (\text{NBCL}(I%) \times \text{NOC}(I%))
\]
IF \text{NBCL}(I%) > \text{MAXC}(21) THEN
\[
\text{MAXC}(21) = \text{NBCL}(I%)
\]
ELSE
\[
\text{MAXC}(21) = \text{MAXC}(21)
\]

46
IF NBRW(I%) > MAXR(21) THEN
   MAXR(21) = NBRW(I%)
ELSE
   MAXR(21) = MAXR(21)
END IF

CASE 22
SUMNOC(22) = SUMNOC(22) + NOC(I%)
SUMNBRWxNOC(22) = SUMNBRWxNOC(22) + (NBRW(I%) * NOC(I%))
SUMNBCLxNOC(22) = SUMNBCLxNOC(22) + (NBCL(I%) * NOC(I%))
IF NBCL(I%) > MAXC(22) THEN
   MAXC(22) = NBCL(I%)
ELSE
   MAXC(22) = MAXC(22)
END IF
IF NBRW(I%) > MAXR(22) THEN
   MAXR(22) = NBRW(I%)
ELSE
   MAXR(22) = MAXR(22)
END IF

CASE 23
SUMNOC(23) = SUMNOC(23) + NOC(I%)
SUMNBRWxNOC(23) = SUMNBRWxNOC(23) + (NBRW(I%) * NOC(I%))
SUMNBCLxNOC(23) = SUMNBCLxNOC(23) + (NBCL(I%) * NOC(I%))
IF NBCL(I%) > MAXC(23) THEN
   MAXC(23) = NBCL(I%)
ELSE
   MAXC(23) = MAXC(23)
END IF
IF NBRW(I%) > MAXR(23) THEN
   MAXR(23) = NBRW(I%)
ELSE
   MAXR(23) = MAXR(23)
END IF

CASE 24
SUMNOC(24) = SUMNOC(24) + NOC(I%)
SUMNBRWxNOC(24) = SUMNBRWxNOC(24) + (NBRW(I%) * NOC(I%))
SUMNBCLxNOC(24) = SUMNBCLxNOC(24) + (NBCL(I%) * NOC(I%))
IF NBCL(I%) > MAXC(24) THEN
   MAXC(24) = NBCL(I%)
ELSE
   MAXC(24) = MAXC(24)
END IF
IF NBRW(I%) > MAXR(24) THEN
   MAXR(24) = NBRW(I%)
ELSE
   MAXR(24) = MAXR(24)
END IF

CASE 25
SUMNOC(25) = SUMNOC(25) + NOC(I%)
SUMNBRWxNOC(25) = SUMNBRWxNOC(25) + (NBRW(I%) * NOC(I%))
SUMNBCLxNOC(25) = SUMNBCLxNOC(25) + (NBCL(I%) * NOC(I%))
IF NBCL(I%) > MAXC(25) THEN
   MAXC(25) = NBCL(I%)
ELSE
   MAXC(25) = MAXC(25)
END IF
IF NBRW(I%) > MAXR(25) THEN
   MAXR(25) = NBRW(I%)
ELSE
   MAXR(25) = MAXR(25)
END IF

CASE 26
SUMNOC(26) = SUMNOC(26) + NOC(I%)
SUMNBRWxNOC(26) = SUMNBRWxNOC(26) + (NBRW(I%) * NOC(I%))
SUMNBCL\times\text{NOC}(26) = \text{SUMNBCL}\times\text{NOC}(26) + (\text{NBCL}(I\%) \times \text{NOC}(I\%))

\text{IF NBCL}(I\%) > \text{MAXC}(26) \text{ THEN}
\text{MAXC}(26) = \text{NBCL}(I\%)
\text{ELSE}
\text{MAXC}(26) = \text{MAXC}(26)
\text{END IF}

\text{IF NBRW}(I\%) > \text{MAXR}(26) \text{ THEN}
\text{MAXR}(26) = \text{NBRW}(I\%)
\text{ELSE}
\text{MAXR}(26) = \text{MAXR}(26)
\text{END IF}

\text{CASE 27}
\text{SUMNOC}(27) = \text{SUMNOC}(27) + \text{NOC}(I\%)
\text{SUMNBRW}\times\text{NOC}(27) = \text{SUMNBRW}\times\text{NOC}(27) + (\text{NBRW}(I\%) \times \text{NOC}(I\%))
\text{SUMNBCL}\times\text{NOC}(27) = \text{SUMNBCL}\times\text{NOC}(27) + (\text{NBCL}(I\%) \times \text{NOC}(I\%))
\text{IF NBCL}(I\%) > \text{MAXC}(27) \text{ THEN}
\text{MAXC}(27) = \text{NBCL}(I\%)
\text{ELSE}
\text{MAXC}(27) = \text{MAXC}(27)
\text{END IF}

\text{IF NBRW}(I\%) > \text{MAXR}(27) \text{ THEN}
\text{MAXR}(27) = \text{NBRW}(I\%)
\text{ELSE}
\text{MAXR}(27) = \text{MAXR}(27)
\text{END IF}

\text{CASE 28}
\text{SUMNOC}(28) = \text{SUMNOC}(28) + \text{NOC}(I\%)
\text{SUMNBRW}\times\text{NOC}(28) = \text{SUMNBRW}\times\text{NOC}(28) + (\text{NBRW}(I\%) \times \text{NOC}(I\%))
\text{SUMNBCL}\times\text{NOC}(28) = \text{SUMNBCL}\times\text{NOC}(28) + (\text{NBCL}(I\%) \times \text{NOC}(I\%))
\text{IF NBCL}(I\%) > \text{MAXC}(28) \text{ THEN}
\text{MAXC}(28) = \text{NBCL}(I\%)
\text{ELSE}
\text{MAXC}(28) = \text{MAXC}(28)
\text{END IF}

\text{IF NBRW}(I\%) > \text{MAXR}(28) \text{ THEN}
\text{MAXR}(28) = \text{NBRW}(I\%)
\text{ELSE}
\text{MAXR}(28) = \text{MAXR}(28)
\text{END IF}

\text{CASE 29}
\text{SUMNOC}(29) = \text{SUMNOC}(29) + \text{NOC}(I\%)
\text{SUMNBRW}\times\text{NOC}(29) = \text{SUMNBRW}\times\text{NOC}(29) + (\text{NBRW}(I\%) \times \text{NOC}(I\%))
\text{SUMNBCL}\times\text{NOC}(29) = \text{SUMNBCL}\times\text{NOC}(29) + (\text{NBCL}(I\%) \times \text{NOC}(I\%))
\text{IF NBCL}(I\%) > \text{MAXC}(29) \text{ THEN}
\text{MAXC}(29) = \text{NBCL}(I\%)
\text{ELSE}
\text{MAXC}(29) = \text{MAXC}(29)
\text{END IF}

\text{IF NBRW}(I\%) > \text{MAXR}(29) \text{ THEN}
\text{MAXR}(29) = \text{NBRW}(I\%)
\text{ELSE}
\text{MAXR}(29) = \text{MAXR}(29)
\text{END IF}

\text{CASE 30}
\text{SUMNOC}(30) = \text{SUMNOC}(30) + \text{NOC}(I\%)
\text{SUMNBRW}\times\text{NOC}(30) = \text{SUMNBRW}\times\text{NOC}(30) + (\text{NBRW}(I\%) \times \text{NOC}(I\%))
\text{SUMNBCL}\times\text{NOC}(30) = \text{SUMNBCL}\times\text{NOC}(30) + (\text{NBCL}(I\%) \times \text{NOC}(I\%))
\text{IF NBCL}(I\%) > \text{MAXC}(30) \text{ THEN}
\text{MAXC}(30) = \text{NBCL}(I\%)
\text{ELSE}
\text{MAXC}(30) = \text{MAXC}(30)
\text{END IF}

\text{IF NBRW}(I\%) > \text{MAXR}(30) \text{ THEN}
\text{MAXR}(30) = \text{NBRW}(I\%)
\text{ELSE}

48


MAXR(30) = MAXR(30)  
END IF
CASE 31

SUMNOC(31) = SUMNOC(31) + NOC(I%)
SUMNBRWxNOC(31) = SUMNBRWxNOC(31) + (NBRW(I%) * NOC(I%))
SUMNBCLxNOC(31) = SUMNBCLxNOC(31) + (NBCL(I%) * NOC(I%))

IF NBCL(I%) > MAXC(31) THEN
  MAXC(31) = NBCL(I%)
ELSE
  MAXC(31) = MAXC(31)
END IF

IF NBRW(I%) > MAXR(31) THEN
  MAXR(31) = NBRW(I%)
ELSE
  MAXR(31) = MAXR(31)
END IF

CASE 32

SUMNOC(32) = SUMNOC(32) + NOC(I%)
SUMNBRWxNOC(32) = SUMNBRWxNOC(32) + (NBRW(I%) * NOC(I%))
SUMNBCLxNOC(32) = SUMNBCLxNOC(32) + (NBCL(I%) * NOC(I%))

IF NBCL(I%) > MAXC(32) THEN
  MAXC(32) = NBCL(I%)
ELSE
  MAXC(32) = MAXC(32)
END IF

IF NBRW(I%) > MAXR(32) THEN
  MAXR(32) = NBRW(I%)
ELSE
  MAXR(32) = MAXR(32)
END IF

END SELECT
END SUB

SUB CLASSIFY

IF FLAVG(I%) < 100 THEN
  IF FWAVG(I%) < 26 THEN NUM = 1
  IF FWAVG(I%) >= 26 AND FWAVG(I%) < 35 THEN NUM = 2
  IF FWAVG(I%) >= 35 AND FWAVG(I%) <= 54 THEN NUM = 3
  IF FWAVG(I%) > 54 THEN NUM = 4
END IF

IF FLAVG(I%) >= 100 AND FLAVG(I%) <= 174 THEN
  IF FWAVG(I%) < 26 THEN NUM = 5
  IF FWAVG(I%) >= 26 AND FWAVG(I%) < 35 THEN NUM = 6
  IF FWAVG(I%) >= 35 AND FWAVG(I%) <= 54 THEN NUM = 7
  IF FWAVG(I%) > 54 THEN NUM = 8
END IF

IF FLAVG(I%) > 174 AND FLAVG(I%) <= 194 THEN
  IF FWAVG(I%) < 26 THEN NUM = 9
  IF FWAVG(I%) >= 26 AND FWAVG(I%) < 35 THEN NUM = 10
  IF FWAVG(I%) >= 35 AND FWAVG(I%) <= 54 THEN NUM = 11
  IF FWAVG(I%) > 54 THEN NUM = 12
END IF

IF FLAVG(I%) > 194 AND FLAVG(I%) <= 199 THEN
  IF FWAVG(I%) < 26 THEN NUM = 13
  IF FWAVG(I%) >= 26 AND FWAVG(I%) < 35 THEN NUM = 14
  IF FWAVG(I%) >= 35 AND FWAVG(I%) <= 54 THEN NUM = 15
  IF FWAVG(I%) > 54 THEN NUM = 16
END IF

IF FLAVG(I%) > 199 AND FLAVG(I%) <= 259 THEN
  IF FWAVG(I%) < 26 THEN NUM = 17
  IF FWAVG(I%) >= 26 AND FWAVG(I%) < 35 THEN NUM = 18
  IF FWAVG(I%) >= 35 AND FWAVG(I%) <= 54 THEN NUM = 19
  IF FWAVG(I%) > 54 THEN NUM = 20
END IF

IF FLAVG(I%) > 259 AND FLAVG(I%) <= 289 THEN

49
IF FWAVG(I%) < 26 THEN NUM = 21
IF FWAVG(I%) >= 26 AND FWAVG(I%) < 35 THEN NUM = 22
IF FWAVG(I%) >= 35 AND FWAVG(I%) <= 54 THEN NUM = 23
IF FWAVG(I%) > 54 THEN NUM = 24
END IF
IF FLAVG(I%) > 289 AND FLAVG(I%) <= 300 THEN
IF FWAVG(I%) < 26 THEN NUM = 25
IF FWAVG(I%) >= 26 AND FWAVG(I%) < 35 THEN NUM = 26
IF FWAVG(I%) >= 35 AND FWAVG(I%) <= 54 THEN NUM = 27
IF FWAVG(I%) > 54 THEN NUM = 28
END IF
IF FLAVG(I%) > 300 THEN
IF FWAVG(I%) < 26 THEN NUM = 29
IF FWAVG(I%) >= 26 AND FWAVG(I%) < 35 THEN NUM = 30
IF FWAVG(I%) >= 35 AND FWAVG(I%) <= 54 THEN NUM = 31
IF FWAVG(I%) > 54 THEN NUM = 32
END IF
END SUB

SUB CLASSIFY2
IF FLAVG(N%) < 100 THEN
IF FWAVG(N%) < 26 THEN NUMBR = 1
IF FWAVG(N%) >= 26 AND FWAVG(N%) < 35 THEN NUMBR = 2
IF FWAVG(N%) >= 35 AND FWAVG(N%) <= 54 THEN NUMBR = 3
IF FWAVG(N%) > 54 THEN NUMBR = 4
END IF
IF FLAVG(N%) >= 100 AND FLAVG(N%) <= 174 THEN
IF FWAVG(N%) < 26 THEN NUMBR = 5
IF FWAVG(N%) >= 26 AND FWAVG(N%) < 35 THEN NUMBR = 6
IF FWAVG(N%) >= 35 AND FWAVG(N%) <= 54 THEN NUMBR = 7
IF FWAVG(N%) > 54 THEN NUMBR = 8
END IF
IF FLAVG(N%) > 174 AND FLAVG(N%) <= 194 THEN
IF FWAVG(N%) < 26 THEN NUMBR = 9
IF FWAVG(N%) >= 26 AND FWAVG(N%) < 35 THEN NUMBR = 10
IF FWAVG(N%) >= 35 AND FWAVG(N%) <= 54 THEN NUMBR = 11
IF FWAVG(N%) > 54 THEN NUMBR = 12
END IF
IF FLAVG(N%) > 194 AND FLAVG(N%) <= 199 THEN
IF FWAVG(N%) < 26 THEN NUMBR = 13
IF FWAVG(N%) >= 26 AND FWAVG(N%) < 35 THEN NUMBR = 14
IF FWAVG(N%) >= 35 AND FWAVG(N%) <= 54 THEN NUMBR = 15
IF FWAVG(N%) > 54 THEN NUMBR = 16
END IF
IF FLAVG(N%) > 199 AND FLAVG(N%) <= 259 THEN
IF FWAVG(N%) < 26 THEN NUMBR = 17
IF FWAVG(N%) >= 26 AND FWAVG(N%) < 35 THEN NUMBR = 18
IF FWAVG(N%) >= 35 AND FWAVG(N%) <= 54 THEN NUMBR = 19
IF FWAVG(N%) > 54 THEN NUMBR = 20
END IF
IF FLAVG(N%) > 259 AND FLAVG(N%) <= 289 THEN
IF FWAVG(N%) < 26 THEN NUMBR = 21
IF FWAVG(N%) >= 26 AND FWAVG(N%) < 35 THEN NUMBR = 22
IF FWAVG(N%) >= 35 AND FWAVG(N%) <= 54 THEN NUMBR = 23
IF FWAVG(N%) > 54 THEN NUMBR = 24
END IF
IF FLAVG(N%) > 289 AND FLAVG(N%) <= 300 THEN
IF FWAVG(N%) < 26 THEN NUMBR = 25
IF FWAVG(N%) >= 26 AND FWAVG(N%) < 35 THEN NUMBR = 26
IF FWAVG(N%) >= 35 AND FWAVG(N%) <= 54 THEN NUMBR = 27
IF FWAVG(N%) > 54 THEN NUMBR = 28
END IF
IF FLAVG(N%) > 300 THEN
IF FWAVG(N%) < 26 THEN NUMBR = 29
IF FWAVG(N%) >= 26 AND FWAVG(N%) < 35 THEN NUMBR = 30
END IF
END SUB
IF FWAVG(N%) >= 35 AND FWAVG(N%) <= 54 THEN NUMBR = 31
IF FWAVG(N%) > 54 THEN NUMBR = 32
END IF

END SUB

SUB DEVIATION

SELECT CASE NUMBR

CASE 1
DEVMUM(1) = DEVNUM(1) + (NBW(N%) - CATAVGR(1)) ^ 2
DEVMUMC(1) = DEVNUMC(1) + (NBCL(N%) - CATAVGC(1)) ^ 2

CASE 2
DEVMUM(2) = DEVNUM(2) + (NBW(N%) - CATAVGR(2)) ^ 2
DEVMUMC(2) = DEVNUMC(2) + (NBCL(N%) - CATAVGC(2)) ^ 2

CASE 3
DEVMUM(3) = DEVNUM(3) + (NBW(N%) - CATAVGR(3)) ^ 2
DEVMUMC(3) = DEVNUMC(3) + (NBCL(N%) - CATAVGC(3)) ^ 2

CASE 4
DEVMUM(4) = DEVNUM(4) + (NBW(N%) - CATAVGR(4)) ^ 2
DEVMUMC(4) = DEVNUMC(4) + (NBCL(N%) - CATAVGC(4)) ^ 2

CASE 5
DEVMUM(5) = DEVNUM(5) + (NBW(N%) - CATAVGR(5)) ^ 2
DEVMUMC(5) = DEVNUMC(5) + (NBCL(N%) - CATAVGC(5)) ^ 2

CASE 6
DEVMUM(6) = DEVNUM(6) + (NBW(N%) - CATAVGR(6)) ^ 2
DEVMUMC(6) = DEVNUMC(6) + (NBCL(N%) - CATAVGC(6)) ^ 2

CASE 7
DEVMUM(7) = DEVNUM(7) + (NBW(N%) - CATAVGR(7)) ^ 2
DEVMUMC(7) = DEVNUMC(7) + (NBCL(N%) - CATAVGC(7)) ^ 2

CASE 8
DEVMUM(8) = DEVNUM(8) + (NBW(N%) - CATAVGR(8)) ^ 2
DEVMUMC(8) = DEVNUMC(8) + (NBCL(N%) - CATAVGC(8)) ^ 2

CASE 9
DEVMUM(9) = DEVNUM(9) + (NBW(N%) - CATAVGR(9)) ^ 2
DEVMUMC(9) = DEVNUMC(9) + (NBCL(N%) - CATAVGC(9)) ^ 2

CASE 10
DEVMUM(10) = DEVNUM(10) + (NBW(N%) - CATAVGR(10)) ^ 2
DEVMUMC(10) = DEVNUMC(10) + (NBCL(N%) - CATAVGC(10)) ^ 2

CASE 11
DEVMUM(11) = DEVNUM(11) + (NBW(N%) - CATAVGR(11)) ^ 2
DEVMUMC(11) = DEVNUMC(11) + (NBCL(N%) - CATAVGC(11)) ^ 2

CASE 12
DEVMUM(12) = DEVNUM(12) + (NBW(N%) - CATAVGR(12)) ^ 2
DEVMUMC(12) = DEVNUMC(12) + (NBCL(N%) - CATAVGC(12)) ^ 2

CASE 13
DEVMUM(13) = DEVNUM(13) + (NBW(N%) - CATAVGR(13)) ^ 2
DEVMUMC(13) = DEVNUMC(13) + (NBCL(N%) - CATAVGC(13)) ^ 2

CASE 14
DEVMUM(14) = DEVNUM(14) + (NBW(N%) - CATAVGR(14)) ^ 2
DEVMUMC(14) = DEVNUMC(14) + (NBCL(N%) - CATAVGC(14)) ^ 2

CASE 15
DEVMUM(15) = DEVNUM(15) + (NBW(N%) - CATAVGR(15)) ^ 2
DEVMUMC(15) = DEVNUMC(15) + (NBCL(N%) - CATAVGC(15)) ^ 2

CASE 16
DEVMUM(16) = DEVNUM(16) + (NBW(N%) - CATAVGR(16)) ^ 2
DEVMUMC(16) = DEVNUMC(16) + (NBCL(N%) - CATAVGC(16)) ^ 2

CASE 17
DEVMUM(17) = DEVNUM(17) + (NBW(N%) - CATAVGR(17)) ^ 2
DEVMUMC(17) = DEVNUMC(17) + (NBCL(N%) - CATAVGC(17)) ^ 2

CASE 18
DEVMUM(18) = DEVNUM(18) + (NBW(N%) - CATAVGR(18)) ^ 2
DEVMUMC(18) = DEVNUMC(18) + (NBCL(N%) - CATAVGC(18)) ^ 2

CASE 19
DEVMUM(19) = DEVNUM(19) + (NBW(N%) - CATAVGR(19)) ^ 2
DEVMUMC(19) = DEVNUMC(19) + (NBCL(N%) - CATAVGC(19)) ^ 2

CASE 20

DEVNUMR(20) = DEVNUMR(20) + (NBRW(N%)) - CATAVGR(20)) ^ 2
DEVNUMC(20) = DEVNUMC(20) + (NBCL(N%)) - CATAVGC(20)) ^ 2

CASE 21
DEVNUMR(21) = DEVNUMR(21) + (NBRW(N%)) - CATAVGR(21)) ^ 2
DEVNUMC(21) = DEVNUMC(21) + (NBCL(N%)) - CATAVGC(21)) ^ 2

CASE 22
DEVNUMR(22) = DEVNUMR(22) + (NBRW(N%)) - CATAVGR(22)) ^ 2
DEVNUMC(22) = DEVNUMC(22) + (NBCL(N%)) - CATAVGC(22)) ^ 2

CASE 23
DEVNUMR(23) = DEVNUMR(23) + (NBRW(N%)) - CATAVGR(23)) ^ 2
DEVNUMC(23) = DEVNUMC(23) + (NBCL(N%)) - CATAVGC(23)) ^ 2

CASE 24
DEVNUMR(24) = DEVNUMR(24) + (NBRW(N%)) - CATAVGR(24)) ^ 2
DEVNUMC(24) = DEVNUMC(24) + (NBCL(N%)) - CATAVGC(24)) ^ 2

CASE 25
DEVNUMR(25) = DEVNUMR(25) + (NBRW(N%)) - CATAVGR(25)) ^ 2
DEVNUMC(25) = DEVNUMC(25) + (NBCL(N%)) - CATAVGC(25)) ^ 2

CASE 26
DEVNUMR(26) = DEVNUMR(26) + (NBRW(N%)) - CATAVGR(26)) ^ 2
DEVNUMC(26) = DEVNUMC(26) + (NBCL(N%)) - CATAVGC(26)) ^ 2

CASE 27
DEVNUMR(27) = DEVNUMR(27) + (NBRW(N%)) - CATAVGR(27)) ^ 2
DEVNUMC(27) = DEVNUMC(27) + (NBCL(N%)) - CATAVGC(27)) ^ 2

CASE 28
DEVNUMR(28) = DEVNUMR(28) + (NBRW(N%)) - CATAVGR(28)) ^ 2
DEVNUMC(28) = DEVNUMC(28) + (NBCL(N%)) - CATAVGC(28)) ^ 2

CASE 29
DEVNUMR(29) = DEVNUMR(29) + (NBRW(N%)) - CATAVGR(29)) ^ 2
DEVNUMC(29) = DEVNUMC(29) + (NBCL(N%)) - CATAVGC(29)) ^ 2

CASE 30
DEVNUMR(30) = DEVNUMR(30) + (NBRW(N%)) - CATAVGR(30)) ^ 2
DEVNUMC(30) = DEVNUMC(30) + (NBCL(N%)) - CATAVGC(30)) ^ 2

CASE 31
DEVNUMR(31) = DEVNUMR(31) + (NBRW(N%)) - CATAVGR(31)) ^ 2
DEVNUMC(31) = DEVNUMC(31) + (NBCL(N%)) - CATAVGC(31)) ^ 2

CASE 32
DEVNUMR(32) = DEVNUMR(32) + (NBRW(N%)) - CATAVGR(32)) ^ 2
DEVNUMC(32) = DEVNUMC(32) + (NBCL(N%)) - CATAVGC(32)) ^ 2

END SELECT
END SUB

SUB DIVBY1
NBCL(I%) = NB(I%)
FWAVG(I%) = FW(I%)
NBRW(I%) = 1

END SUB

SUB DIVBY2
NBCL(I%) = (NB(I%) / 2)
FWAVG(I%) = FW(I%) / 2
NBRW(I%) = 2

END SUB

SUB DIVBY3
NBCL(I%) = (NB(I%) / 3)
FWAVG(I%) = FW(I%) / 3
NBRW(I%) = 3

END SUB

SUB DIVBY4
NBCL(I%) = (NB(I%) / 4)
FWAVG(I%) = FW(I%) / 4
NBRW(I%) = 4

END SUB
SUB DIVBY5
    NBCL(I%) = (NB(I%) / 5)
    FWAVG(I%) = FW(I%) / 5
    NBRW(I%) = 5
END SUB

SUB DIVBY6
    NBCL(I%) = (NB(I%) / 6)
    FWAVG(I%) = FW(I%) / 6
    NBRW(I%) = 6
END SUB

SUB DIVBY7
    NBCL(I%) = (NB(I%) / 7)
    FWAVG(I%) = FW(I%) / 7
    NBRW(I%) = 7
END SUB

SUB LABEL
    IF M% = 1 THEN PRINT #2, " (AA) ";
    IF M% = 2 THEN PRINT #2, " (AB) ";
    IF M% = 3 THEN PRINT #2, " (AC) ";
    IF M% = 4 THEN PRINT #2, " (AD) ";
    IF M% = 5 THEN PRINT #2, " (BA) ";
    IF M% = 6 THEN PRINT #2, " (BB) ";
    IF M% = 7 THEN PRINT #2, " (BC) ";
    IF M% = 8 THEN PRINT #2, " (BD) ";
    IF M% = 9 THEN PRINT #2, " (CA) ";
    IF M% = 10 THEN PRINT #2, " (CB) ";
    IF M% = 11 THEN PRINT #2, " (CC) ";
    IF M% = 12 THEN PRINT #2, " (CD) ";
    IF M% = 13 THEN PRINT #2, " (DA) ";
    IF M% = 14 THEN PRINT #2, " (DB) ";
    IF M% = 15 THEN PRINT #2, " (DC) ";
    IF M% = 16 THEN PRINT #2, " (DD) ";
    IF M% = 17 THEN PRINT #2, " (EA) ";
    IF M% = 18 THEN PRINT #2, " (EB) ";
    IF M% = 19 THEN PRINT #2, " (EC) ";
    IF M% = 20 THEN PRINT #2, " (ED) ";
    IF M% = 21 THEN PRINT #2, " (FA) ";
    IF M% = 22 THEN PRINT #2, " (FB) ";
    IF M% = 23 THEN PRINT #2, " (FC) ";
    IF M% = 24 THEN PRINT #2, " (FD) ";
    IF M% = 25 THEN PRINT #2, " (GA) ";
    IF M% = 26 THEN PRINT #2, " (GB) ";
    IF M% = 27 THEN PRINT #2, " (GC) ";
    IF M% = 28 THEN PRINT #2, " (GD) ";
    IF M% = 29 THEN PRINT #2, " (HA) ";
    IF M% = 30 THEN PRINT #2, " (HB) ";
    IF M% = 31 THEN PRINT #2, " (HC) ";
    IF M% = 32 THEN PRINT #2, " (HD) ";
END SUB

SUB MESSAGE
    LINE (225, 270)-(410, 350), 9, B
    COLOR 11
    LOCATE 19, 33: PRINT "Input complete."
    COLOR 14
    LOCATE 20, 33: PRINT "Please wait for"
    LOCATE 21, 33: PRINT "computations..."
    COLOR 15
END SUB

SUB RESULTS
    CLS

53
LINE (90, 175)-(560, 245), 9, B
COLOR 12
LOCATE 13, 38: PRINT "FINISHED!"
COLOR 15
LOCATE 14, 20: PRINT "The results have been saved in ";
COLOR 11
PRINT FILEO$
COLOR 15
********************************************************************
PRINT #2, "•"; SPC(16); RIVER$; " RIVER, MILEMARKER DESIGNATION: ";
PRINT #2, "•"; SPC(33); DATE$; TAB(75); "•"
PRINT #2, "•"; SPC(34); TIMES; TAB(75); "•"
PRINT #2, "•"; SPC(35); (P R I N T 2, "AVERAGE NUMBER OF"; TAB(36); "COLUMN"; TAB(48); "AVERAGE NUMBER OF"; TAB(70); "ROW";
PRINT #2, TAB(15); "BARGES IN COLUMN"; TAB(36); "MAXIMUM"; TAB(48); "BARGES IN THE ROW"; TAB(68); "MAXIMUM"
PRINT #2, TAB(16); "(AVERAGE NUMBER OF"; TAB(48); "(AVERAGE NUMBER OF"
PRINT #2, TAB(15); "BARGES IN COLUMN"; TAB(48); "BARGES IN THE ROW"
PRINT #2, TAB(16); "PLUS 2 STD DEVS")"; TAB(48); "PLUS 2 STD DEVS")
PRINT #2,
FOR M% = 1 TO 32
  IF M% = 5 THEN PRINT #2,
  IF M% = 9 THEN PRINT #2,
  IF M% = 13 THEN PRINT #2,
  IF M% = 17 THEN PRINT #2,
  IF M% = 21 THEN PRINT #2,
  IF M% = 25 THEN PRINT #2,
  IF M% = 29 THEN PRINT #2,
  PRINT #2, USING "###"; TAB(2); M%;
  CALL LABEL
  PRINT #2, USING "###.#####"; TAB(16); CATAVGC(M%);
  PRINT #2, TAB(24); "(";
  PRINT #2, USING "###.#####"; TAB(25); (CATAVGC(M%) + STDC2(M%));
  PRINT #2, TAB(32); ")";
  PRINT #2, USING "###.#####"; TAB(36); MAXC(M%);
  IF MAXC(M%) < (CATAVGC(M%) + STDC2(M%)) THEN PRINT #2, "•";
  END IF
  PRINT #2, USING "###.#####"; TAB(48); CATAVGR(M%);
  PRINT #2, TAB(56); "(";
  PRINT #2, USING "###.#####"; TAB(57); (CATAVGR(M%) + STDR2(M%));
  PRINT #2, TAB(64); ")";
  PRINT #2, USING "###.#####"; TAB(68); MAXR(M%);
  IF MAXR(M%) < (CATAVGR(M%) + STDR2(M%)) THEN PRINT #2, "•";
  ELSE PRINT #2, "•"
  END IF
NEXT M%
END SUB
Appendix IV:

Barge Distribution by Category

NOTE: Based upon the U.S. Army Corps of Engineers barge length and width designations, there are 32 possible categories. However, it was determined by the computer program that there are actually only 24 barge categories occurring on the inland waterway system of the U.S. In addition, the program has shown there to be only 12 categories occurring on the Maysville section of the Ohio River.
<table>
<thead>
<tr>
<th></th>
<th>Total Barges</th>
<th>column</th>
<th>row</th>
<th>total</th>
<th>ADJUSTED</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>AA</td>
<td>13</td>
<td>0.00001</td>
<td>0.00001</td>
<td>0.00001</td>
</tr>
<tr>
<td>2</td>
<td>AB</td>
<td>50</td>
<td>0.00001</td>
<td>0.00001</td>
<td>0.00001</td>
</tr>
<tr>
<td>3</td>
<td>AC</td>
<td>1</td>
<td>4.40001</td>
<td>1.20001</td>
<td>5.28001</td>
</tr>
<tr>
<td>4</td>
<td>AD</td>
<td>0</td>
<td>0.00001</td>
<td>0.00001</td>
<td>0.00001</td>
</tr>
<tr>
<td>5</td>
<td>BA</td>
<td>0</td>
<td>1.00001</td>
<td>1.00001</td>
<td>1.00001</td>
</tr>
<tr>
<td>6</td>
<td>BB</td>
<td>43</td>
<td>3.33331</td>
<td>1.66671</td>
<td>5.00001</td>
</tr>
<tr>
<td>7</td>
<td>BC</td>
<td>1170</td>
<td>3.42191</td>
<td>1.71881</td>
<td>5.14071</td>
</tr>
<tr>
<td>8</td>
<td>BD</td>
<td>0</td>
<td>3.25001</td>
<td>1.25001</td>
<td>4.50001</td>
</tr>
<tr>
<td>9</td>
<td>CA</td>
<td>3</td>
<td>0.00001</td>
<td>0.00001</td>
<td>0.00001</td>
</tr>
<tr>
<td>10</td>
<td>CB</td>
<td>67</td>
<td>0.00001</td>
<td>0.00001</td>
<td>0.00001</td>
</tr>
<tr>
<td>11</td>
<td>CC</td>
<td>571</td>
<td>3.34001</td>
<td>1.96671</td>
<td>5.30671</td>
</tr>
<tr>
<td>12</td>
<td>CD</td>
<td>11</td>
<td>0.00001</td>
<td>0.00001</td>
<td>0.00001</td>
</tr>
<tr>
<td>13</td>
<td>DA</td>
<td>0</td>
<td>0.00001</td>
<td>0.00001</td>
<td>0.00001</td>
</tr>
<tr>
<td>14</td>
<td>DB</td>
<td>233</td>
<td>5.00001</td>
<td>1.00001</td>
<td>6.00001</td>
</tr>
<tr>
<td>15</td>
<td>DC</td>
<td>51269</td>
<td>4.58371</td>
<td>2.82741</td>
<td>7.41111</td>
</tr>
<tr>
<td>16</td>
<td>DD</td>
<td>11</td>
<td>6.00001</td>
<td>2.00001</td>
<td>8.00001</td>
</tr>
<tr>
<td>17</td>
<td>EA</td>
<td>0</td>
<td>0.00001</td>
<td>0.00001</td>
<td>0.00001</td>
</tr>
<tr>
<td>18</td>
<td>EB</td>
<td>4</td>
<td>5.00001</td>
<td>1.00001</td>
<td>6.00001</td>
</tr>
<tr>
<td>19</td>
<td>EC</td>
<td>4822</td>
<td>4.58371</td>
<td>2.82741</td>
<td>7.41111</td>
</tr>
<tr>
<td>20</td>
<td>ED</td>
<td>15</td>
<td>0.00001</td>
<td>0.00001</td>
<td>0.00001</td>
</tr>
<tr>
<td>21</td>
<td>FA</td>
<td>0</td>
<td>0.00001</td>
<td>0.00001</td>
<td>0.00001</td>
</tr>
<tr>
<td>22</td>
<td>FB</td>
<td>0</td>
<td>1.00001</td>
<td>2.00001</td>
<td>3.00001</td>
</tr>
<tr>
<td>23</td>
<td>FC</td>
<td>70</td>
<td>3.35371</td>
<td>2.31591</td>
<td>5.67561</td>
</tr>
<tr>
<td>24</td>
<td>FD</td>
<td>1</td>
<td>0.00001</td>
<td>0.00001</td>
<td>0.00001</td>
</tr>
<tr>
<td>25</td>
<td>GA</td>
<td>0</td>
<td>0.00001</td>
<td>0.00001</td>
<td>0.00001</td>
</tr>
<tr>
<td>26</td>
<td>GB</td>
<td>0</td>
<td>0.00001</td>
<td>0.00001</td>
<td>0.00001</td>
</tr>
<tr>
<td>27</td>
<td>GC</td>
<td>2628</td>
<td>3.38841</td>
<td>1.98761</td>
<td>5.37601</td>
</tr>
<tr>
<td>28</td>
<td>GD</td>
<td>15</td>
<td>0.00001</td>
<td>0.00001</td>
<td>0.00001</td>
</tr>
<tr>
<td>29</td>
<td>HA</td>
<td>0</td>
<td>0.00001</td>
<td>0.00001</td>
<td>0.00001</td>
</tr>
<tr>
<td>30</td>
<td>HB</td>
<td>0</td>
<td>0.00001</td>
<td>0.00001</td>
<td>0.00001</td>
</tr>
<tr>
<td>31</td>
<td>HC</td>
<td>30</td>
<td>2.00001</td>
<td>1.71761</td>
<td>3.71761</td>
</tr>
<tr>
<td>32</td>
<td>HD</td>
<td>61</td>
<td>1.66671</td>
<td>1.00000</td>
<td>2.66671</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>61073</strong></td>
<td></td>
<td></td>
<td><strong>5114</strong></td>
<td><strong>5367</strong></td>
</tr>
</tbody>
</table>
Appendix V:

Equivalent Static Loads Calculations

NOTE: Calculations are performed for the 24 possible flotilla categories, but for the Maysville section of the Ohio River, only 12 categories are significant.
**THE MAYSVILLE KENTUCKY BRIDGE OVER THE OHIO RIVER**

**BARGE EQUIVALENT STATIC IMPACT FORCE CALCULATIONS**

**Barge Design Impact Velocity (fps)**

West Pier: Barge $V = 7.0$ mph (10.27 fps),
Waterway $V = 5.7$ fps.

$V_w = (10.27 + 5.7)$

**Barge Design Impact Velocity (fps)**

West Pier: Barge $V = 7.0$ mph (10.27 fps),
Waterway $V = 6.1$ fps.

$V_E = (10.27 + 6.1)$

**Hydrodynamic Coefficient**

$C_H = 1.05$

**Barge Row Displacement (tons): By flotilla type, $i = 1,2,...,24.$**

$T_i$ defines the 95.5 percentile barge tonnages.

<table>
<thead>
<tr>
<th>$T_1$</th>
<th>$T_2$</th>
<th>$T_3$</th>
<th>$T_4$</th>
<th>$T_5$</th>
<th>$T_6$</th>
<th>$T_7$</th>
<th>$T_8$</th>
<th>$T_9$</th>
<th>$T_{10}$</th>
<th>$T_{11}$</th>
<th>$T_{12}$</th>
<th>$T_{13}$</th>
<th>$T_{14}$</th>
<th>$T_{15}$</th>
<th>$T_{16}$</th>
<th>$T_{17}$</th>
<th>$T_{18}$</th>
<th>$T_{19}$</th>
<th>$T_{20}$</th>
<th>$T_{21}$</th>
<th>$T_{22}$</th>
<th>$T_{23}$</th>
<th>$T_{24}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>609</td>
<td>953</td>
<td>4486</td>
<td>501</td>
<td>1420</td>
<td>1226</td>
<td>3414</td>
<td>3664</td>
<td>1868</td>
<td>3653</td>
<td>421</td>
<td>1890</td>
<td>2157</td>
<td>2643</td>
<td>1156</td>
<td>1375</td>
<td>3046</td>
<td>7714</td>
<td>5315</td>
<td>4260</td>
<td>6477</td>
<td>7497</td>
<td>8383</td>
<td>6350</td>
</tr>
</tbody>
</table>
Average Flotilla Column Tonnage: Category barge tonnage times the category 95.5 percentile number of barges in a flotilla column. Categories with zero column length do not occur on the Maysville section of the Ohio River.

| $T_1$  | $T_2$  | $T_3$  | $T_4$  | $T_5$  | $T_6$  | $T_7$  | $T_8$  | $T_9$  | $T_{10}$ | $T_{11}$ | $T_{12}$ | $T_{13}$ | $T_{14}$ | $T_{15}$ | $T_{16}$ | $T_{17}$ | $T_{18}$ | $T_{19}$ | $T_{20}$ | $T_{21}$ | $T_{22}$ | $T_{23}$ | $T_{24}$ |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| $T_1 = T_1 \cdot 0.0$ | $T_2 = T_2 \cdot 0.0$ | $T_3 = T_3 \cdot 0.0$ | $T_4 = T_4 \cdot 0.0$ | $T_5 = T_5 \cdot 4.0$ | $T_6 = T_6 \cdot 4.0$ | $T_7 = T_7 \cdot 5.92$ | $T_8 = T_8 \cdot 0.0$ | $T_9 = T_9 \cdot 0.0$ | $T_{10} = T_{10} \cdot 5.11$ | $T_{11} = T_{11} \cdot 0.0$ | $T_{12} = T_{12} \cdot 5.0$ | $T_{13} = T_{13} \cdot 5.38$ | $T_{14} = T_{14} \cdot 6.0$ | $T_{15} = T_{15} \cdot 0.0$ | $T_{16} = T_{16} \cdot 5.0$ | $T_{17} = T_{17} \cdot 5.38$ | $T_{18} = T_{18} \cdot 0.0$ | $T_{19} = T_{19} \cdot 4.50$ | $T_{20} = T_{20} \cdot 0.0$ | $T_{21} = T_{21} \cdot 4.0$ | $T_{22} = T_{22} \cdot 0.0$ | $T_{23} = T_{23} \cdot 3.23$ | $T_{24} = T_{24} \cdot 2.0$

Barge Flotilla Kinetic Energy

West Tower Pier (k-ft)

\[
KE_{W_i} = \frac{C \cdot H \cdot T_i \cdot 2 \cdot (V \cdot W)^2}{2 \cdot 32.2}
\]

<table>
<thead>
<tr>
<th>$i = 1, 2 \ldots 24$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0$</td>
</tr>
<tr>
<td>$0$</td>
</tr>
<tr>
<td>$0$</td>
</tr>
<tr>
<td>$0$</td>
</tr>
<tr>
<td>$0$</td>
</tr>
<tr>
<td>$0$</td>
</tr>
<tr>
<td>$0$</td>
</tr>
<tr>
<td>$4.08 \cdot 10^4$</td>
</tr>
<tr>
<td>$1.68 \cdot 10^5$</td>
</tr>
<tr>
<td>$0$</td>
</tr>
<tr>
<td>$0$</td>
</tr>
<tr>
<td>$1.55 \cdot 10^5$</td>
</tr>
<tr>
<td>$0$</td>
</tr>
<tr>
<td>$7.86 \cdot 10^4$</td>
</tr>
</tbody>
</table>

Barge Flotilla Kinetic Energy

East Tower Pier (k-ft)

\[
KE_{E_i} = \frac{C \cdot H \cdot T_i \cdot 2 \cdot (V \cdot E)^2}{2 \cdot 32.2}
\]

<table>
<thead>
<tr>
<th>$i = 1, 2 \ldots 12$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0$</td>
</tr>
<tr>
<td>$0$</td>
</tr>
<tr>
<td>$0$</td>
</tr>
<tr>
<td>$0$</td>
</tr>
<tr>
<td>$0$</td>
</tr>
<tr>
<td>$0$</td>
</tr>
<tr>
<td>$0$</td>
</tr>
<tr>
<td>$4.29 \cdot 10^4$</td>
</tr>
<tr>
<td>$1.77 \cdot 10^5$</td>
</tr>
<tr>
<td>$0$</td>
</tr>
<tr>
<td>$0$</td>
</tr>
<tr>
<td>$1.63 \cdot 10^5$</td>
</tr>
<tr>
<td>$0$</td>
</tr>
<tr>
<td>$8.26 \cdot 10^4$</td>
</tr>
</tbody>
</table>
### KE $\mathcal{W}_i$

<table>
<thead>
<tr>
<th>$i$</th>
<th>$1.21 \cdot 10^5$</th>
<th>$1.32 \cdot 10^5$</th>
<th>$5.72 \cdot 10^4$</th>
<th>$1.36 \cdot 10^5$</th>
<th>$1.99 \cdot 10^5$</th>
<th>$2.15 \cdot 10^5$</th>
<th>$2.25 \cdot 10^5$</th>
<th>$1.06 \cdot 10^5$</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>14</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>15</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>16</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>17</td>
<td>1.36 \cdot 10^5</td>
<td>1.99 \cdot 10^5</td>
<td>2.15 \cdot 10^5</td>
<td>2.25 \cdot 10^5</td>
<td>1.06 \cdot 10^5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>1.32 \cdot 10^5</td>
<td>1.99 \cdot 10^5</td>
<td>2.15 \cdot 10^5</td>
<td>2.25 \cdot 10^5</td>
<td>1.06 \cdot 10^5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### KE $\mathcal{E}_i$

<table>
<thead>
<tr>
<th>$i$</th>
<th>$1.28 \cdot 10^5$</th>
<th>$1.39 \cdot 10^5$</th>
<th>$6.01 \cdot 10^4$</th>
<th>$1.43 \cdot 10^5$</th>
<th>$2.09 \cdot 10^5$</th>
<th>$2.26 \cdot 10^5$</th>
<th>$2.37 \cdot 10^5$</th>
<th>$1.11 \cdot 10^5$</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>14</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>15</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>16</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>17</td>
<td>1.43 \cdot 10^5</td>
<td>2.09 \cdot 10^5</td>
<td>2.26 \cdot 10^5</td>
<td>2.37 \cdot 10^5</td>
<td>1.11 \cdot 10^5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>1.39 \cdot 10^5</td>
<td>2.09 \cdot 10^5</td>
<td>2.26 \cdot 10^5</td>
<td>2.37 \cdot 10^5</td>
<td>1.11 \cdot 10^5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

### Barge Width Correction Factors: Using the Most Conservative Width in the Barge Category.

\[ R_{B_1} = \frac{25.70}{35} \]
\[ R_{B_2} = \frac{33.13}{35} \]
\[ R_{B_3} = \frac{54.00}{35} \]
\[ R_{B_4} = \frac{55.00}{35} \]
\[ R_{B_5} = \frac{25.00}{35} \]
\[ R_{B_6} = \frac{33.59}{35} \]
\[ R_{B_7} = \frac{54.00}{35} \]
\[ R_{B_8} = \frac{59.30}{35} \]
\[ R_{B_9} = \frac{26.98}{35} \]
\[ R_{B_{10}} = \frac{54.00}{35} \]
\[ R_{B_{11}} = \frac{60.00}{35} \]
\[ R_{B_{12}} = \frac{26.74}{35} \]
\[ R_{B_{13}} = \frac{37.49}{35} \]
\[ R_{B_{14}} = \frac{54.00}{35} \]
\[ R_{B_{15}} = \frac{25.00}{35} \]
\[ R_{B_{16}} = \frac{26.00}{35} \]
\[ R_{B_{17}} = \frac{43.23}{35} \]
\[ R_{B_{18}} = \frac{72.00}{35} \]
\[ R_{B_{19}} = \frac{54.00}{35} \]
\[ R_{B_{20}} = \frac{62.69}{35} \]
\[ R_{B_{21}} = \frac{54.00}{35} \]
\[ R_{B_{22}} = \frac{56.64}{35} \]
\[ R_{B_{23}} = \frac{54.00}{35} \]
\[ R_{B_{24}} = \frac{55.82}{35} \]
<table>
<thead>
<tr>
<th>$a_{BW_i}$</th>
<th>$a_{BE_i}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>19.79</td>
<td>20.46</td>
</tr>
<tr>
<td>29.98</td>
<td>30.87</td>
</tr>
<tr>
<td>28.6</td>
<td>0</td>
</tr>
<tr>
<td>38.11</td>
<td>0</td>
</tr>
<tr>
<td>35.56</td>
<td>36.64</td>
</tr>
<tr>
<td>25.95</td>
<td>26.73</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>31.98</td>
<td>33.02</td>
</tr>
<tr>
<td>33.06</td>
<td>34.05</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>33.09</td>
<td>34.06</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>34.67</td>
<td>35.68</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>35.57</td>
<td>36.6</td>
</tr>
<tr>
<td>21.93</td>
<td>22.61</td>
</tr>
</tbody>
</table>

Barge Equivalent Static Impact Force $P_{BW_i}$ for the West Tower Pier (kips)

$$P_{BW_i} = (1349 + 110 \cdot a_{BW_i}) \cdot R_{B_i}$$

Barge Equivalent Static Impact Force $P_{BE_i}$ for the East Tower Pier (kips)

$$P_{BE_i} = (1349 + 110 \cdot a_{BE_i}) \cdot R_{B_i}$$
\begin{align*}
P_{BW_1} &= 0.0 \\
P_{BW_2} &= 0.0 \\
P_{BW_3} &= 0.0 \\
P_{BW_4} &= 0.0 \\
P_{BW_5} &= 0.0 \\
P_{BW_6} &= 0.0 \\
P_{BW_7} &= 0.0 \\
P_{BW_8} &= 0.0 \\
P_{BW_9} &= 0.0 \\
P_{BW_{10}} &= 0.0 \\
P_{BW_{11}} &= 0.0 \\
P_{BW_{12}} &= 0.0 \\
P_{BW_{13}} &= 0.0 \\
P_{BW_{14}} &= 0.0 \\
P_{BW_{15}} &= 0.0 \\
P_{BW_{16}} &= 0.0 \\
P_{BW_{17}} &= 0.0 \\
P_{BW_{18}} &= 0.0 \\
P_{BW_{19}} &= 0.0 \\
P_{BW_{20}} &= 0.0 \\
P_{BW_{21}} &= 0.0 \\
P_{BW_{22}} &= 0.0 \\
P_{BE_1} &= 0.0 \\
P_{BE_2} &= 0.0 \\
P_{BE_3} &= 0.0 \\
P_{BE_4} &= 0.0 \\
P_{BE_5} &= 0.0 \\
P_{BE_6} &= 0.0 \\
P_{BE_7} &= 0.0 \\
P_{BE_8} &= 0.0 \\
P_{BE_9} &= 0.0 \\
P_{BE_{10}} &= 0.0 \\
P_{BE_{11}} &= 0.0 \\
P_{BE_{12}} &= 0.0 \\
P_{BE_{13}} &= 0.0 \\
P_{BE_{14}} &= 0.0 \\
P_{BE_{15}} &= 0.0 \\
P_{BE_{16}} &= 0.0 \\
P_{BE_{17}} &= 0.0 \\
P_{BE_{18}} &= 0.0 \\
P_{BE_{19}} &= 0.0 \\
P_{BE_{20}} &= 0.0 \\
P_{BE_{21}} &= 0.0 \\
P_{BE_{22}} &= 0.0 \\
\end{align*}
BARGE EQUIVALENT STATIC IMPACT FORCE
CALCULATIONS FOR A SINGLE FREE DRIFTING BARGE

Barge Design Impact Velocity (fps)
- West Pier: Barge V = 0.0 mph
  & Waterway V = 6.8 fps
- East Pier: Barge V = 0.0 mph
  & Waterway V = 7.1 fps

\[ V_w = 6.8 \]
\[ V_e = 7.1 \]

Single Free-Drifting Barge Loaded Tonnage (tons):
\[ T_1 = 6477 \]

Barge Kinetic Energy
- West Tower Pier (k-ft)
  \[ i = 1 \quad R_{B_1} = 1.53 \]
  \[ KE_{W_1} = \frac{C_H T_i^2 V_w^2}{2 \cdot 32.2} \]
  \[ KE_{W_1} = 9.77 \cdot 10^3 \]
- East Tower Pier (k-ft)
  \[ i = 1 \quad R_{B_1} = 1.53 \]
  \[ KE_{E_1} = \frac{C_H T_i^2 V_e^2}{2 \cdot 32.2} \]
  \[ KE_{E_1} = 1.06 \cdot 10^4 \]

Barge Damage Depth \( a_{BW} \)
- West Tower Pier (ft.)
  \[ a_{BW_1} = \frac{\left( KE_{W_1} \right)^{1/2}}{R_{B_1}} \cdot 10.2 \]
  \[ a_{BW_1} = 4.33 \]
- East Tower Pier (ft.)
  \[ a_{BE_1} = \frac{\left( KE_{E_1} \right)^{1/2}}{R_{B_1}} \cdot 10.2 \]
  \[ a_{BE_1} = 4.64 \]

Barge Equivalent Static Impact Force \( P_{BW} \) for
- West Tower Pier (kips)
  \[ P_{BW_1} = (1349 + 110 \cdot a_{BW_1}) \cdot R_{B_1} \]
  \[ P_{BW_1} = 2.79 \cdot 10^3 \]
- East Tower Pier (kips)
  \[ P_{BE_1} = (1349 + 110 \cdot a_{BE_1}) \cdot R_{B_1} \]
  \[ P_{BE_1} = 2.85 \cdot 10^3 \]