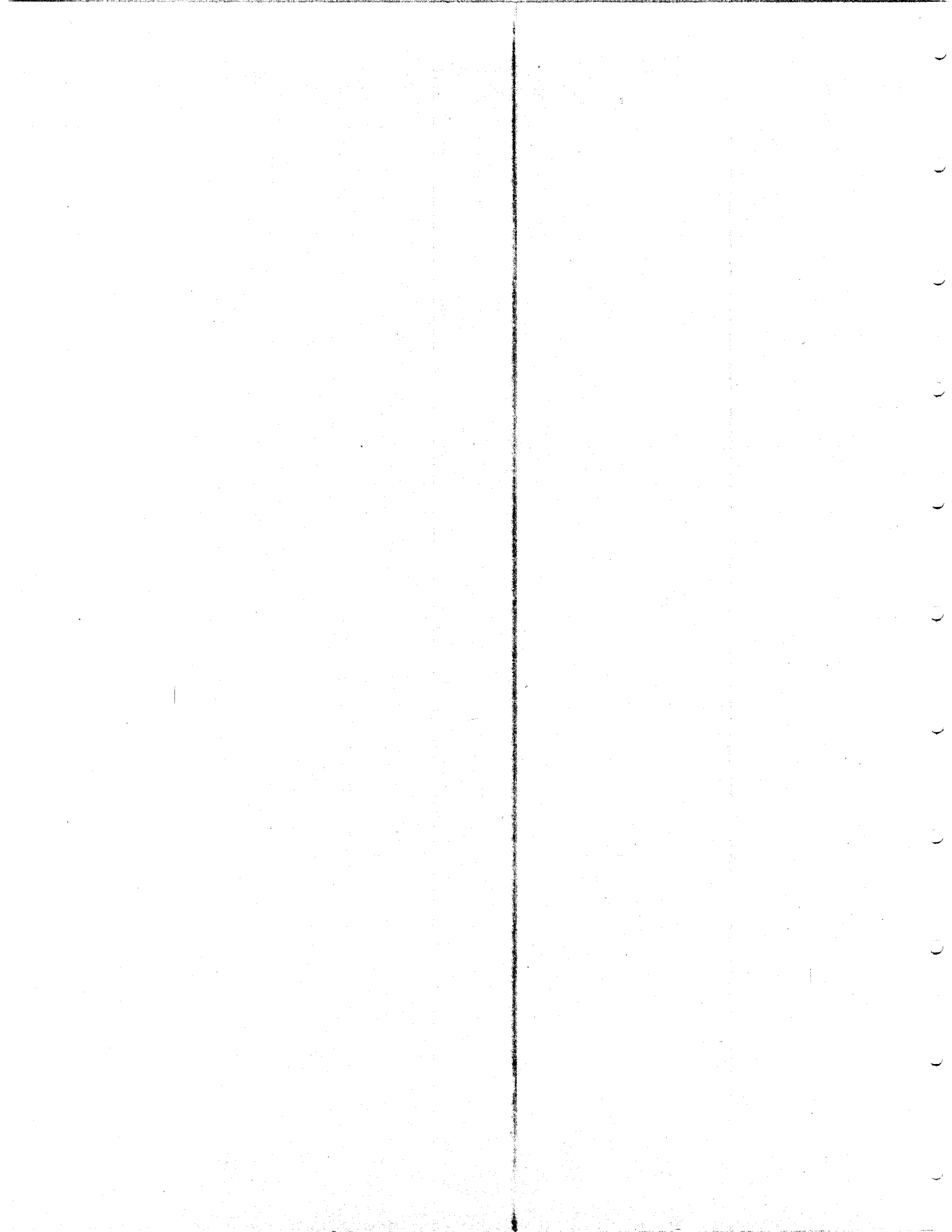

Users Guide to

RMA4 - Version 4.27

Draft Copy

**US Army Corps of Engineers
Waterways Experiment Station**



RMA4, VERSION 4.27**T1-T3 Job Title (required)**

| <u>Field</u> | <u>Variable</u> | <u>Value</u> | <u>Description</u> |
|--------------|-----------------|--------------|---|
| 0, C 1 | IC1 | T | Card group identifier |
| 0, C 2 | IC2 | 1, 2, 3 | Card group identifier |
| 1-10 | TITLE | Any | Any alpha-numeric data, up to 77 characters |

Any number of T1 and T2 cards may be used and the sequence is not significant. Only one T3 card may be used and it must be the last title card in the set. The program reads the "3" as meaning END of the T cards.

\$F Formatted or Fixed Field Input (optional)

| <u>Field</u> | <u>Variable</u> | <u>Value</u> | <u>Description</u> |
|--------------|-----------------|--------------|---|
| 0, C 1-2 | IC1 | \$F | Card group identifier Specifies fixed field (formatted) run control input. Required for formatted input data. |

\$L **Logical Unit Control** **(required)**

| <u>Field</u> | <u>Variable</u> | <u>Value</u> | <u>Description</u> |
|--------------|-----------------|--------------|---|
| 0, C 1-2 | IC1 | \$L | Card group identifier |
| 1 | IGEON | + | File number for geometric input. Typically the binary output from GFGEN (RMA1). (default lu = 10) |
| 2 | IVELN | + | File number for input flow and depths. Binary output from an RMA2 run. (default lu = 20) |
| 3 | IHOTN | + | File for input initial quality conditions. (default lu = 30) |
| 4 | IALTBC | + | File number for alternate input file for time varying boundary conditions, see text. (default lu = 4) |
| 5 | IFINO | + | File number for binary output of final results (default lu = 31) |
| 6 | IHOTO | + | File number for binary output of restart quality conditions. (default lu = 32) |
| 7 | IOT | + | File number for full print output of results (default lu = 33) |
| 8 | ISPRT | + | File number for special summary output of results. (default lu = 34) |

NOTE: The file numbers are automatically assigned the default if the value is positive. Negative entries allow the user to assign their own file numbering. A zero indicates the file is never used. (The HEC-style card input is read on logical unit 3)

\$M**Machine Identifier****(required)**

| <u>Field</u> | <u>Variable</u> | <u>Value</u> | <u>Description</u> |
|--------------|-----------------|--------------|---|
| 0, C 1-2 | IC1 | \$M | Card group identifier |
| 1 | IVRSID | + | <p>Controller for record length and word size for front solver buffering.</p> <p>= 1 Micro with Definicon 032 Board Direct access record length. Unlimited and defined in terms of bytes.</p> <p>= 2 Prime Mini-computer with direct access record length. Unlimited and defined in terms of short words (ie, 2 bytes).</p> <p>= 3 Dec VAX with direct access record length. Limited to 32K bytes and defined in terms of long words (4 bytes).</p> <p>= 4 Apple MAC II using ABSOFT FORTRAN, Definicon 020 Board, or Dec VAX to avoid short record length. Direct access defined files that are opened as required. CAUTION: many files are left on disk.</p> <p>= 5 Cray or Cyber 205. Direct access for systems using 64 bit or 8 byte words and whose record lengths are defined in bytes.</p> <p>= 6 Same as option 4 above, except the names of the files that are open will not contain a '.'</p> |

\$M**\$M**

CO COMMENT CARD (optional)

| <u>Field</u> | <u>Variable</u> | <u>Value</u> | <u>Description</u> |
|--------------|-----------------|--------------|------------------------|
| 0, C 1-2 | IC1 | CO | Card group Identifier |
| 1-10 | FLD | A | Any alpha-numeric data |

Comments may be supplied on this card any where within the run control input.

CS RMA4 Flow Control Structures (optional)

| <u>Field</u> | <u>Variable</u> | <u>Value</u> | <u>Description</u> |
|--|-----------------|--------------|--|
| 0, C 1-2 | IC1 | CS | Card group identifier |
| 1 | NJN | + | Flow controller identifier >= 904. Applies these parameters to IMAT = NJN |
| 2 | NJT | + | RMA4 flow controller type = 1 match concentrations = 2 lock operation |
| If NJT = 2, fields 3-6 must be specified | | | |
| 3 | ALFA1 | + | Angle of control structure in radians counterclockwise from the positive X axis. |
| 4 | VOLLK | + | Volume of the lock (ft3) ?? |
| 5 | GAMLK | + | Mixing exchange factor for a locking event (0.0 <= GAMLK <= 1.0) |
| 6 | ALOCF | + | Locking frequency per hour (decimal ???) |

DF Card**Full Diffusion Coefficient
(Combination of DX & DY)****(required)**

| <u>Field</u> | <u>Variable</u> | <u>Value</u> | <u>Description</u> |
|--------------|-----------------|--------------|---|
| 0, C 1-2 | IC1 | DF | Card group identifier |
| 1 | J | | Element material type (IMAT) |
| 2 | ORT(J,1) | - | Invokes automatic scaling of x and y diffusion of the element type J (m ² /sec). Scaling is a function of both velocity and grid size. Example: -20 will multiply the x diffusion auto-scale by 20. |
| | | + | X-direction diffusion coefficient of element type J (m ² /sec) |
| 3 | ORT(J,2) | + | Y-direction diffusion coefficient of element type J (m ² /sec) Note: If auto-scaling is invoked the y diffusion will be multiplied by Ort(J,2) |

DM Wetting and Drying by Marsh Porosity (optional)

| <u>Field</u> | <u>Variable</u> | <u>Value</u> | <u>Description</u> |
|--------------|-----------------|-------------------|--|
| 0, C 1-2 | IC1 | DM | Card group identifier |
| 0, C 3 | IC3 | b/ N E T | Option 1: IDNOPT Option 2: Wet and dry by node Option 3: Wet and dry by element Option 4: Wet and dry by IMAT |
| 1 | J | -, 0, + | For option 1, J = IDNOPT J = 0 Marsh option inoperative. All DM cards are ignored. J = -1 Use given default values for all nodes J = -2 User specifies values for all nodes J = + User specifies values for all nodes >= J For option 2, code the node # For option 3, code element # For option 4 code the IMAT # |
| 2 | WDMC1 | + | Depth shift (default = 3.0 FT) |
| 3 | WDMC2 | + | Depth range over which section reduces (default = 2.0 FT) |
| 4 | WDMC3 | + | Minimum active fraction over lower section (Kappa default = 0.02) |
| 5 | WDMC4 | + | Absolute bottom elevation of the marsh channel. |

DMb/ (DM blank) card is required, then optionally followed by DMT, DME, or DMN cards. If a node receives multiple assignments, the last assignment is processed.

DX Card Diffusion Coefficient in X-Plane (optional)

| <u>Field</u> | <u>Variable</u> | <u>Value</u> | <u>Description</u> |
|--------------|-----------------|--------------|---|
| 0, C 1-2 | IC1 | DX | Card group identifier |
| 1 | J | | Element material type (IMAT) |
| 2 | ORT(J,1) | | X-direction diffusion coefficient of element type J (m ² /sec) |

DY Card Diffusion Coefficient in Y-Plane (optional)

| <u>Field</u> | <u>Variable</u> | <u>Value</u> | <u>Description</u> |
|--------------|-----------------|--------------|---|
| 0, C 1-2 | IC1 | DY | Card group identifier |
| 1 | J | | Element material type (IMAT) |
| 2 | ORT(J,2) | | Y-direction diffusion coefficient of element type J (m ² /sec) |

FT Card Water Temperature (optional)

| <u>Field</u> | <u>Variable</u> | <u>Value</u> | <u>Description</u> |
|--------------|-----------------|--------------|--|
| 0, C 1-2 | IC1 | FT | Card group identifier |
| 1 | WTEMP | | Average Initial water temperature in degrees Celsius |

NOTE: If no FT card is present, 15 degrees Celsius is used.

FQ Card Fluid Qualities Concentration (required)

| <u>Field</u> | <u>Variable</u> | <u>Value</u> | <u>Description</u> |
|--------------|-----------------|--------------|---|
| 0, C 1-1 | IC1 | FQ | Card group identifier |
| 1 | NQAL | + | Number of quality constituents |
| 2 | IDOS | 0, + | = 1 dissolved oxygen and BOD are constituents 1 and 2 , respectively. = 0 otherwise BOD => biological oxygen demand |

FQC Card**Fluid Qualities, Decay Control**

| <u>Field</u> | <u>Variable</u> | <u>Value</u> | <u>Description</u> |
|--------------|-----------------|--------------|--|
| 0, C 1-2 | IC1 | FQ | Card group identifier |
| 0, C 3 | IC3 | C | Card group identifier |
| 1 | XKCOEF | + | Decay coefficient for each constituent. (day ⁻¹) Provide a decay coefficient for each constituent as specified by NQAL on FQ-card. 0 No decay ∞ decay rapidly |

NOTE: $\frac{C(t)}{C(+ = 0)} = e^{-XKCOEF(t)}$

where t = time in days
 C(+) = concentration
 C(+ = 0) = concentration at time 0

GC Card Continuity Check Line Calculation
(required if using BCL card)

| <u>Field</u> | <u>Variable</u> | <u>Value</u> | <u>Description</u> |
|--------------|-----------------|--------------|---|
| 0, C 1-2 | IC1 | GC | Card group identifier |
| 1 | | | Continuity line # |
| 2 | LINE(K,J) | | Corner node number 1, ... number 8. If a continuation line is needed (> 8 numbers in formatted input), start in field 1 of next GC card (maximum of 150 nodes per check line). End each list with a (-1) |

Mass flux continuity can be calculated at up to 150 lines across part or all of the grid. Prescribe the boundary line first since that line is used in calculating the percents displayed on all subsequent lines. Code corner nodes only. Code all lines in the same direction; otherwise, sign changes will occur in the printout. In general, code right to left when facing downstream. The first list should be the inflow boundary because it will be assumed to be 100%.

GE Card GRID, Element Connection Table (optional)

The element connection table will usually be provided by the GFGEN preprocessor as defined by \$L-card. If so, this card is not required. If small revisions are indicated code the nodal point-element connection table.

| <u>Field</u> | <u>Variable</u> | <u>Value</u> | <u>Description</u> |
|--------------|-----------------|--------------|--|
| 0, C 1-2 | IC1 | GE | Card group identifier |
| 1 | J | | Element number |
| 2-9 | NOP(J,I) | | Up to 8 node numbers for element J, listed counterclockwise around the element STARTING FROM ANY CORNER. |
| 10 | IMAT(J) | | Element type (optional, may be specified on GT card) |
| 11 | ANG(J) | | Element orientation for eddy viscosity tensor (radians measured counterclockwise from positive X-axis) |

GN Card Grid, Nodal Point Coordinates (optional)

| <u>Field</u> | <u>Variable</u> | <u>Value</u> | <u>Description</u> |
|-------------------------|-----------------|--------------|--|
| 0, C 1-2 | IC1 | GN | Card group identifier |
| 0, C 3 | IC3 | b | Option 1: Code X and Y coordinates only |
| 0, C 3 | IC3 | N | Option 2: Code X and Y coordinates and bed bottom elevations (as in GFGEN) |
| 1 | J | | Node number |
| 2 | CORD(J,1) | | X-coordinate input at node J |
| 3 | CORD(J,2) | | Y-coordinate input at node J |
| 4 | WD(J) | | bottom elevation at node J |
| For 1D problem continue | | | |
| 5 | WIDTH(J) | | Channel width at zero depth for node J |
| 6 | SS1(J) | | Left side slope |
| 7 | SS2(J) | | Right side slope |
| 8 | WIDS(J) | | Storage width associated with zero depth |

GS Grid, General Geometry Parameters (optional)

| <u>Field</u> | <u>Variable</u> | <u>Value</u> | <u>Description</u> |
|--------------|-----------------|--------------|---|
| 0, C 1-2 | IC1 | GS | Card group identifier |
| 1 | XSCALE | 0,+ | Scale factor for X - coordinate. Default = 1.0 |
| 2 | YSCALE | 0,+ | Scale factor for Y - coordinate. Default = 1.0 |

NOTE: To convert feet to meters, the scale factor should be
.3048

GT Grid, Element Types (optional)

| <u>Field</u> | <u>Variable</u> | <u>Value</u> | <u>Description</u> |
|--------------|-----------------|--------------|--|
| 0, C 1-2 | IC1 | GT | Card group identifier |
| 1 | J | | Element number |
| 2 | IMAT(J) | | Element type |
| 3-10 | | | Need as many (J, IMAT(J) sets) as GE cards present. |

GV Card Grid, Eddy Viscosity Tensor (optional)

| <u>Field</u> | <u>Variable</u> | <u>Value</u> | <u>Description</u> |
|--------------|-----------------|--------------|--|
| 0, C 1-2 | IC1 | GV | Card group identifier |
| 1 | J | + | Element number |
| 2 | ANG | -, 0, + | Direction of eddy viscosity tensor (Radians, counterclockwise from x-axis) |

NOTE: Need as many (J, ANG(J) sets) as GE cards present. Continue to fill the card with element and direction pairs, then use another GV card. Default angle is zero.

GW Card 1-Dimensional Node Width Assignment (optional)

| <u>Field</u> | <u>Variable</u> | <u>Value</u> | <u>Description</u> |
|--------------|-----------------|--------------|--|
| 0, C 1-2 | IC1 | GW | Card group Identifier |
| 0, C 3 | IC3 | b | Option 1: Universal assignment for all nodes |
| | | N | Option 2: individual node assignment |
| 1 | NODE | | Corner 1D node number |
| 2 | WIDTH | | Channel width at zero depth |
| 3 | SS1 | | Left side slope |
| 4 | SS2 | | Right side slope |
| 5 | WIDS | | Storage width associated with zero depth |

HD Card **Water Depth** **(optional)**

| <u>Field</u> | <u>Variable</u> | <u>Value</u> | <u>Description</u> |
|--------------|-----------------|--------------|---|
| 0, C 1-2 | IC1 | HD | Card group identifier |
| 1 | LOC1 | + | Starting node number at which this global assignment will be made |
| 2 | VEL(3,LOC1) | | Depth of water at node LOC1 (meters) |

HU Card **X-Velocity** **(optional)**

| <u>Field</u> | <u>Variable</u> | <u>Value</u> | <u>Description</u> |
|--------------|-----------------|--------------|---|
| 0, C 1-2 | IC1 | HU | Card group Identifier |
| 1 | LOC1 | | Starting node number at which this global assignment will be made |
| 2 | VEL(1,LOC1) | | X- velocity at node LOC1 (meters/sec) |

HV Card **Y-Velocity** **(optional)**

| <u>Field</u> | <u>Variable</u> | <u>Value</u> | <u>Description</u> |
|--------------|-----------------|--------------|---------------------------------------|
| 0, C 1-2 | IC1 | HV | Card group identifier |
| 1 | LOC1 | | Node number |
| 2 | VEL(2,LOC1) | | Y- velocity at node LOC1 (meters/sec) |

HS Card **Hydrodynamic Scale Factors** **(optional)**

| <u>Field</u> | <u>Variable</u> | <u>Value</u> | <u>Description</u> |
|--------------|-----------------|--------------|--|
| 0, C -12 | IC1 | IC | Card group identifier |
| 1 | USCALE | | X velocity scale factor. May be used to convert input to M/SEC. Default = 1.0 |
| 2 | VSCALE | | Y velocity scale factor. May be used to convert input to M/SEC. Default = 1.0 |
| 3 | WSCALE | | Depth scale factor. May be used to convert input to M/SEC. Default = 1.0 |

*NOTE: Set scale to .3048 to convert English to metric.

**IC Card Initial Quality Concentration (required for
COLDSTART)**

| <u>Field</u> | <u>Variable</u> | <u>Value</u> | <u>Description</u> |
|--------------|-----------------|--------------|--|
| 0, C 1-2 | IC1 | IC | Card group identifier |
| 0, C 3 | IC3 | b/ | Option 1: universal assignment |
| 0, C 3 | IC3 | T | Option 2: for material type |
| 0, C 3 | IC3 | E | Option 3: for element number |
| 0, C 3 | IC3 | N | Option 4: for node number |
| 1 | ISTART | + | Option 1: Starting node number for universal assignment Option 2: the material type (IMAT) Option 3: the element number Option 4: the node number |
| 2 | TOLD | + | Initial quality concentration, () Enter from 1 to the maximum number of quality constituents (NQAL) |

RE Card **Re-Solve Solution Technique**

| <u>Field</u> | <u>Variable</u> | <u>Value</u> | <u>Description</u> |
|--------------|-----------------|--------------|--|
| 0, C 1-2 | IC1 | RE | Card group identifier |
| 1 | ISAV | | Re-solve save switch = -1 do not save global matrix for resolution = 0 act on value of IRESL = 1 save global matrix for resolution |
| 2 | IRESL | | Re-solve restore switch = 0 act on value of ISAV = N use resolve file saved during time step N |
| 3 | DELT | | Time step for this solution step (hours). Value used only when ISAV is active. Time step from resolve file is used if IRESL is active. |

NOTE: skip this card if delt = 0.0, ie, steady state.

TC Card **Time Control** **(required)**

| <u>Field</u> | <u>Variable</u> | <u>Value</u> | <u>Description</u> |
|--------------|-----------------|--------------|--|
| 0, C 1-2 | IC1 | TC | Card group identifier |
| 1 | TSTART | | Starting time for simulation(hours) |
| 2 | DELTA | | Time step (hours) |
| 3 | NTIME | | Total number of time steps |
| 4 | TMAX | | Maximum simulation time (hours) |
| 5 | SSF | | Steady state flag -1 → ALPHA is 1.0 and time terms are on 0 → time terms are omitted otherwise ALPHA = 1.5 (2nd order in time) |

TH Card **Timing for Hydrodynamics** **(required)**

| <u>Field</u> | <u>Variable</u> | <u>Value</u> | <u>Description</u> |
|--------------|-----------------|--------------|--|
| 0, C 1-2 | IC1 | TH | Card group identifier |
| 1 | TCORR | | Hours to be subtracted from input velocity file generated by RMA2. |
| 2 | TEND | | Time of last step on input velocity file |

NOTE: Upon reaching 'TEND', the RMA2 velocity file will rewind to be used again.

TO Card Timing for Binary Output File Write (optional*)

| <u>Field</u> | <u>Variable</u> | <u>Value</u> | <u>Description</u> |
|--------------|-----------------|--------------|---|
| 0, C 1-2 | IC1 | TO | Card group |
| 1 | TMOD | -,0 | Save all computed time steps (ie TMOD = DELT, see TC-Card) |
| | | + | Decimal hour frequency to save final results. Example: 0.25 will save at 1/4 hours |
| | BEGINT | - | Save all times satisfying TMOD |
| | | 0,+ | Decimal hour to begin saving final results |
| | ENDT | - | Save all times satisfying TMOD |
| | | + | Decimal hour to stop saving final results |

*NOTE: All computed time steps are saved if this card is missing.

Example: TO 0 100 200 will save all computed time steps between 100 and 200, inclusive.

TP Card Trace by Constituents for All Nodes (required)

| <u>Field</u> | <u>Variable</u> | <u>Value</u> | <u>Description</u> |
|--------------|-----------------|--------------|---|
| 0, C 1-2 | IC1 | TP | Card group identifier |
| 1 | IPRT | 0-2 | Print option: = 0 suppress node/element print = 1 print all input data & expanded form of results = 2 suppress node and element data and print short form of the results |
| 2 | NTSEG | 0-+ | Print interval = 0 no print = + use modulo function to determine print interval |
| 3 | IECHO | 0-1 | Input Card Echo Print = 0 Suppress = 1 Print |
| 4 | ITRACE | 0-1 | = 0 no subroutine trace = 1 trace program logic as each subroutine is called |
| 5 | OHGOSH | 0-4 | = 0 no detail internal print trace = 1-4 diagnostic debug print trace |

TQ Card **Trace by Quality** (optional)

| <u>Field</u> | <u>Variable</u> | <u>Value</u> | <u>Description</u> |
|--------------|-----------------|--------------|--|
| 0, C 1-2 | IC1 | TQ | Card group identifier |
| 0, C 3 | IC3 | 1 | Constituent 1 |
| 0, C 3 | IC3 | 2 | Constituent 2 |
| 0, C 3 | IC3 | 3 | Constituent 3 |
| 0, C 3 | IC3 | 4 | Constituent 4 |
| 0, C 3 | IC3 | 5 | Constituent 5 |
| 0, C 3 | IC3 | 6 | Constituent 6 |
| 1 | JSPRT(J,1) | | Node number(s) end the list with a (-1) |

TR Card **Trace the Following Nodes for All Active** (optional)
Constituents

| <u>Field</u> | <u>Variable</u> | <u>Value</u> | <u>Description</u> |
|--------------|-----------------|--------------|---|
| 0, C 1-2 | IC1 | TR | Card group identifier |
| 0, C 3 | IC3 | N | trace for all active constituents at node JSPRT |
| 1 | JSPRT(J,1) | | Node number(s) End the list with a -1 |

BCC Card**Boundary Condition Type****(optional)**

The parameters on this card are necessary if and only if the user wishes to revise the boundary condition update parameters between dynamic time steps. If this card is present for steady state, the boundary condition parameters specified on previous cards (TZ, G1, and BW) will be overruled.

| <u>Field</u> | <u>Variable</u> | <u>Value</u> | <u>Description</u> |
|--------------|-----------------|--------------|---|
| 0, C 1-2 | IC1 | BC | Card group identifier |
| 0, C 3 | IC3 | C | Card group identifier |
| 1 | DELTN | | The delta time step length in decimal hours (DELT is revised only if the value is > 0) |
| 2 | IQF | | The number of time steps to be skipped off the boundary condition input file. |

END Card **Used to Separate Time Steps** **(required)**

| <u>Field</u> | <u>Variable</u> | <u>Value</u> | <u>Description</u> |
|--------------|-----------------|--------------|--------------------------|
| 0, C 1-2 | IC1 | EN | Card group identifier |
| 0, C 3 | IC3 | D | Card group identifier |
| 1-10 | FLD | A | may be used for comments |

This card signals the end of boundary condition input for a given time step.

STOP Card **Stop Simulation** **(required)**

| <u>Field</u> | <u>Variable</u> | <u>Value</u> | <u>Description</u> |
|--------------|-----------------|--------------|--------------------------|
| 0, C 1-2 | IC1 | ST | Card group identifier |
| 0, C 3 | IC3 | O | Card group identifier |
| 2-10 | FLD | A | may be used for comments |

This card will override any previous control concerning the length of the RMA4 simulation.