

## ReadMe File for HydroDyn v2.00.10a-gjh

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*Oct 3, 2013*

[HydroDyn](#) is a time-domain hydrodynamics module that can be coupled into the FAST wind turbine computer-aided engineering (CAE) tool to enable aero-hydro-servo-elastic simulation of offshore wind turbines. HydroDyn is applicable to both fixed-bottom and floating offshore substructures. This latest release of HydroDyn follows the requirement of the FAST modularization framework, couples to [FAST v8.03](#), and provides new capability (relative to prior versions) for modeling the hydrodynamic loading on multi-member substructures. HydroDyn can also be driven as a standalone code to compute hydrodynamic loading uncoupled to FAST.

HydroDyn allows for multiple approaches for calculating the hydrodynamic loads on a structure: a potential-flow theory solution, a strip theory solution, or a combination of the two. HydroDyn is currently limited to linear wave theory with no wave stretching.

The potential-flow solution includes linear hydrostatic restoring, the added mass and damping contributions from linear wave radiation, including free-surface memory effects, and the incident-wave excitation from linear diffraction. The hydrodynamic coefficients required for this solution must be supplied by a separate frequency-domain panel code (i.e., WAMIT) from a pre-computation step. The radiation memory effect can be calculated either through direct time-domain convolution or through a new linear state-space approach, with a state-space model derived through the [SS Fitting](#) preprocessor.

The strip-theory solution may be preferable for substructures or members of substructures that are small in diameter relative to a typical wavelength. The strip-theory solution has been expanded dramatically in this release of HydroDyn; strip-theory hydrodynamic loads can now be applied across multiple interconnected members, each with possible incline and taper. The strip-theory loads include the relative form of Morison's equation for the distributed inertia, added mass, and viscous drag components. Additional distributed load components include loads from static (buoyancy) and dynamic pressure. Hydrodynamic loads are also applied as lumped loads on member endpoints (called joints). It is also possible to include flooding or ballasting of members, and the effects of marine growth.

For some substructures and sea conditions, the hydrodynamic loads from a potential-flow theory must be augmented with the loads brought about by flow separation. For this, the viscous-drag component of the Morison's equation may be included with the potential-flow theory solution. Another option available is to supply a global damping matrix (linear or quadratic) to the system to represent this effect.

When HydroDyn is coupled to FAST, HydroDyn receives the position, orientation, velocities, and accelerations of the (rigid or flexible) substructure at each coupling time step and then computes the hydrodynamic loads and returns them back to FAST. At this time, FAST's ElastoDyn structural-dynamics module assumes for a floating platform that the substructure (floating platform) is a six degree-of-

freedom (DOF) rigid body. For fixed-bottom offshore wind turbines, FAST's SubDyn module allows for structural flexibility of multi-member substructures, but the coupling between SubDyn and HydroDyn has not yet been completed.

The HydroDyn input file defines the substructure geometry, hydrodynamic coefficients, incident wave kinematics and current, potential-flow solution options, flooding/ballasting and marine growth, and auxiliary parameters. The geometry of strip-theory members is defined by joint coordinates in the global reference system, with the origin at the intersection of the undeflected tower centerline with mean sea level (MSL). A member connects two joints; multiple members can use a common joint. The hydrodynamic loads are computed at nodes, which are the resultant of member refinement into multiple (MDivSize input) elements (nodes are located at the ends of each element), and they are calculated by the code. Member properties include outer diameter, thickness, drag, and added mass coefficients. Member properties are specified at the joints; if properties change from one joint to the other, they will be linearly interpolated for the inner nodes.

*While we are very excited about this release and the new capability it brings to FAST, please be aware that this is the initial release. As with anything new, we encourage users to take appropriate precautions. We have tested many features, but not all. Please interpret the results carefully and report back any confirmed errors to the NREL developer. Further development, verification, and validation work is ongoing at NREL. Check back regularly to obtain the latest version of the code.*

## Major changes in HydroDyn v2.00.01a-gjh

HydroDyn has previously been included as an undocumented feature of FAST and packaged with the FAST archive. The former software called “HydroDyn” has been separated into a distinct module packaged separately from FAST (but still coupled to FAST) and itself has been split into two pieces of software, each following the [FAST modularization framework](#):

1. The new HydroDyn continues to model the hydrodynamics problem, but no longer includes the mooring system model; however a linearized mooring system can be modeled using new user-supplied preload, stiffness, and damping terms.
2. The new Mooring Analysis Program ([MAP](#)) has been introduced to model mooring systems. This module is included in a separate archive.

In addition, the new HydroDyn archive ships with HydroDynDriver\_win32.exe, a driver program that can be used to test HydroDyn outside of FAST, but still using the new modularization framework. It controls the standalone simulation progress.

HydroDyn v2.00.01a-gjh has the following features compared to the version of HydroDyn that was previously released with FAST v7.02:

HydroDyn Features	v7.02	v8.03
• Linear regular or irregular waves	✓	✓
• White-noise waves		✓
• Wave stretching	✓	
• Externally generated wave data	✓	
• Sea current	✓	✓
• Morison's equation for central member	✓	✓
• Morison's equation for multiple intersecting members		✓
• Static buoyancy and dynamic pressure on members		✓
• Support for inclined and tapered members		✓
• Support for flooded and ballasted members		✓
• Support for marine growth		✓
• First-order potential flow (from WAMIT)	✓	✓
• Radiation "memory effect" captured through time-domain convolution	✓	✓

- |  |   |
|--|---|
| <ul style="list-style-type: none"> <li>• Radiation "memory effect" captured through linear state-space form</li> </ul> | ✓ |
|--|---|



## Limitations

This list contains the features that are not yet implemented:

- No wave stretching (WaveStMod = 0)
- Variable water depth is disabled (MSL2SWL = 0)
- The feature to auto-generate all possible output channels is disabled (OutAll = FALSE)
- Joint overlap calculations are disabled (JointOvrlp = 0)
- HydroDyn platform force flags must be set to TRUE
- No linearization
- No tight-coupling to FAST
- Radiation memory effect time step (RdtnDT) must match FAST simulation time step
- HydroDyn does not output to file the load contribution from user-supplied preload, stiffness, damping, and drag at the platform-reference point; however they are used in the calculation of the total hydrodynamic loading at the platform reference point sent to FAST
- HydroDyn does not output to file the load contribution from the added mass terms; however they are used in the calculation of the total hydrodynamic loading send to FAST
- The code places the platform reference point at (0,0,0) in the global coordinate system

## Future Work

- Enable wave stretching
- Enable water depth variation
- Enable full support for floating platform force flags.
- Enable joint overlap calculations
- Support for user-defined wave time history
- Enable auto-generation of all possible output channels
- Output to file loads from user-supplied preload, stiffness, damping, and drag
- Output to file loads due to added mass
- Allow for a platform reference point location other than (0,0,0)
- Add second-order wave kinematics and hydrodynamic loads
- Add wave directional spreadingFurther verification using data from the IEA Wind Task 23/30 OC3/OC4 projects
- Further validation with test data
- Add nonlinear regular wave kinematics models for fixed-bottom substructures
- Add breaking wave-impact loads for fixed-bottom substructures
- Add floating platform hydro-elastics
- Add pressure mapping for floating platforms
- Further documentation in a HydroDyn user's guide and theory manual

## Running the Stand-alone HydroDynDriver.exe

You must supply the standalone HydroDynDriver.exe program with the filename of a driver input file. For example from the command prompt,

```
>HydroDynDriver.exe MyDriverFile.dvr
```

Where MyDriverFile.dvr is the name of the HydroDyn driver file. This file is only needed if you are running HydroDyn via the HydroDynDriver.exe program. When coupled to FAST, FAST does not require this file. However, both FAST and HydroDynDriver.exe require a HydroDyn input file as described below.

Units are in SI system (kg, m, s, N).

## Driver Input File

The driver input file contains inputs which would normally be generated by FAST, and are necessary to control the hydrodynamic simulation. Set the **Echo** flag in this file to TRUE if you wish to have HydroDynDriver.exe echo the contents of the driver input file. The echo file has the naming convention of OutRootName.dvr.echo. **OutrootName** is specified in the HYDRODYN section of the driver input file. Set the gravity constant using the **Gravity** parameter. **HDInputFile** is the filename of the HydroDyn input file. This name should be in quotations and can contain an absolute path or a relative path. All HydroDyn-generated output files will be prefixed with **OutRootName**. If this parameter includes a filepath, the output will be generated in that folder. **NSteps** specifies the number of simulation time steps, and **TimeInterval** specifies the time between steps. Setting **WAMITInputsMod** = 0 forces all platform reference point (PRP) input motions to zero for all time. If you set **WAMITInputsMod** = 1, then you must set the steady-state inputs in the WAMIT STEADY STATE INPUTS section of the file. In this version, the MORISON INPUTS and MORISON STEADY STATE INPUTS sections are ignored.

## HydroDyn Input File

In general, please refer to the sample input file provided below for a description of input file parameters. Some specific comments or limitations will be called out in the following sections, but not all inputs are described.

Set the **Echo** flag in this file to TRUE if you wish to have HydroDyn echo the contents of the HydroDyn input file. The echo file has the naming convention of InputFilename.echo. InputFilename is the name of the original HydroDyn input file.

## Environmental Conditions

**WtrDens** specifies the water density and must be value greater than zero. **WtrDpth** specifies the water depth and must be value greater than zero. **MSL2SWL** is the offset between the MSL and the still water level (SWL), positive upward. In this version of HydroDyn, you must enter at value of 0. Future versions of HydroDyn will allow you to change this parameter and hence alter the water depth without having to alter the other input geometry.

## Waves

Refer to the sample input file for a description of these input parameters. However both **WaveMod** and **WaveStMod** have limitations for this release, which we plan to relax in future releases.

**WaveMod** specifies the incident wave kinematics model. The options are:

- 0: none=still water
- 1: plane progressive (regular)
- 1P#: plane progressive with user-specified phase, for example 1P20.0 for a regular wave with a 20° phase (without P#, the phase will be random)
- 2: JONSWAP/Pierson-Moskowitz spectrum (irregular)
- 3: White noise spectrum (irregular)
- 4: user-defined spectrum from routine UserWaveSpctrm (irregular)
- 5: GH Bladed wave data (option has been disabled for this release)

This version does not include the ability to model stretching incident wave kinematics to the instantaneous free surface, you must set **WaveStMod** = 0.

### Floating Platform Force Flags

This release requires that all platform force flags be set to TRUE. Future releases will allow you to turn on/off one or more of the six platform force components.

### Floating Platform Additional Stiffness and Damping

The vectors and matrices of this section are used to generate additional loads on the platform (in addition to other hydrodynamic terms calculated by HydroDyn), per the following equation.

$$F = F_0 - [C]q - [B]\dot{q} - [B_{quad}]ABS(\dot{q})\dot{q}$$

where,  $F_0$  corresponds to the AddF0 force vector,  $[C]$  to the AddCLin linear stiffness matrix,  $[B]$  to the AddBLin linear damping matrix,  $[B_{quad}]$  to the AddBQuad quadratic drag matrix, and  $q$  to the PRP six DOF displacement vector (three translations, three rotations, with the overdot referring to the first time-derivative). These terms can be used e.g. to model a linearized mooring system or to “tune” HydroDyn to matrix experimental results. The resulting force is applied at the PRP and will only be applied if **HasWAMIT** is set to TRUE.

### Heave Coefficients

Drag, added mass, and dynamic pressure loads are computed at member endpoints (joints). The hydrodynamic coefficients for the lumped drag and added mass are referred to as “heave coefficients.” Heave drag will be calculated for all member joints. Heave added-mass and dynamic pressure loads will only be calculated for member joints of members not modeled with WAMIT (**PropWAMIT** = FALSE). You must specify at least one set of heave coefficients, but they may be set to zero if you wish to ignore heave effects. Heave effects are only calculated at user-specified joints (and not at joints HydroDyn will automatically create as part its solution process). For example, if you want heave effects at a marine-growth boundary (where HydroDyn automatically adds a joint), you must explicitly set a joint at that location.

### Member Joints

Joint coordinates are specified in the global reference system, with the origin at the intersection of the undeflected tower centerline with the MSL. **JointHvID** corresponds to an entry in the HEAVE COEFFICIENTS table and sets the heave coefficients for a joint. This version of HydroDyn cannot

calculate joint overlap when multiple members meet at a common joint; therefore **JointOvrp** must be set to 0. Future releases will enable joint overlap calculations. Modeling a fixed-bottom substructure (such as a monopile, tripod or jacket) requires that the lowest member joint(s) lie below the water depth. Placing the joint at the water depth results in a floating platform (or gravity base substructure) where static pressure loads will be applied at the bottom.

## Members

**MJointID1** specifies the starting joint and corresponds to an identifier (ID) from the MEMBER JOINTS table. **MJointID2** specifies the ending joint. Likewise, **MPropSetID1** corresponds to the starting cross-section properties and **MProSetID2** specify the ending cross-section properties. This allows for tapered members. Each member in your model will have drag and added mass coefficients. These are specified using one of three models (**MCoefMod**). Model 1 uses a single set of coefficients. Model 2 is depth-based, is determined via the table found in the DEPTH-BASED YDRODYNAMIC COEFFICIENTS section. Model 3 specifies these coefficients for a particular member, by referring to an ID in the MEMBER-BASED HYDRODYNAMIC COEFFICIENTS. **MDivSize** determines the spacing (in meters) between nodes; the smaller the number, the finer the resolution and longer the computational time. **PropWAMIT** indicates that the corresponding member overlaps with the body represented by the potential-flow (WAMIT) solution, meaning that only drag loads will be computed for that member.

## Filled Members

Specify fluid-filled members using this section. **FillNumN** specifies the number of members in the fill group. **FillMList** is a list of **FillNumN** number of **MemberIDs**. **FillFSLoc** specifies the Z-height of the free-surface (0 for MSL). The code currently does not check for values conflicting **FillFSLoc** across fill groups. **FillDens** is the density of the fluid. If **FillDens** = DEFAULT, then **FillDens** = **WtrDens**.

## Marine Growth

You can add marine growth to members using this depth-based table. Marine growth for a particular location in the platform geometry is added by linearly interpolating between the marine growth table entries. A single zone is created based on the smallest and largest values of **MGDpth**. If you want regions of zero marine growth thickness within these bounds you must generate depth entries which explicitly set **MGThck** to zero. The hydrodynamic coefficient tables contain coefficients with and without marine growth. If **MGThck** = 0 for a particular node, the coefficients not associated with marine growth are used.

## Member Output List

HydroDyn can only generate per length load outputs for up to 9 locations on up 9 different members, for a total of 81 possible distributed load output locations. **NMOutputs** specifies the number of members. You must create a table entry for each requested member. Within a table entry, **MemberID** is the ID specified in the MEMBERS table, and **NOutLoc** specifies how many outputs location are generated for this member. **NodeLocs** specifies those locations as a normalized distance from the starting joint to the ending joint of the member. 0.0 corresponds to a location at the starting joint. If the chosen location does not align with a calculation node, the results at the two surrounding nodes will

be linearly interpolated. The section MESH-BASED OUTPUTS determine which quantities are actually output at these locations.

### Joint Output List

HydroDyn can generate up to 9 different joint outputs. These correspond to the lumped loads at a given user-specified joint. ***JOutLst*** contains a list of ***NJOutputs*** number of ***JointIDs***. The section MESH-BASED OUTPUTS determines which quantities are actually output at these locations.

### Output

Specifying ***HDSum*** = TRUE causes HydroDyn to generate a summary file with a file postfix of ***\_HydroDyn.sum***. This file includes:

- The Wave Number and Complex Values of the Wave Elevations as a Function of Frequency
- Radiation Memory Effect Convolution Kernel
- Simulation Node table
- Simulation Element table
- Summary of User-Requested Outputs
- Platform Volume Calculations
- Integrated Buoyancy Loads
- Integrated Marine Growth Weights

For this version, ***OutAll*** must be set to FALSE. In future versions, setting ***OutAll*** = TRUE will cause HydroDyn to auto-generate outputs for every joint and member in the input file. If ***OutSwitch*** is set to 1, outputs are sent to a file with the post-fix ***\_HydroDyn.out***. If ***OutSwitch*** is set to 2, outputs are sent to the calling program (FAST) for writing. If ***OutSwitch*** is set to 3, both file outputs occur.

### Floating Platform Outputs

This section controls which output quantities are generated for the platform reference point.

***HasWAMIT*** must be set to TRUE to generate these outputs. If HydroDyn encounters an unknown/invalid channel name, it will still generate a column in the output file, but that channel will be marked as INVALID and the values will all be set to zero. Please refer to WAMITOutListParameters.xlsx for a complete list of outputs.

### Mesh-based Outputs

This section controls which output quantities are generated for the requested MEMBER OUTPUT LIST and JOINT OUTPUT LIST. If HydroDyn encounters an unknown/invalid channel name, it will still generate a column in the output file, but that channel will be marked as INVALID and the values will all be set to zero. Please refer to MorisonOutListParameters.xlsx for a complete list of outputs.



## Sample Input File

```

----- HydroDyn v2.00.* Input File -----
Certification Test_001. Exercising File Echo parameter = TRUE
TRUE      Echo      - Echo the input file data (flag)
----- ENVIRONMENTAL CONDITIONS -----
1025.0     WtrDens     - Water density (kg/m^3)
45.0       WtrDpth     - Water depth (meters)
0.0        MSL2SWL    - Offset between still-water level and mean sea level (meters) [positive upward; must be zero if HasWAMIT=TRUE]
----- WAVES -----
2          WaveMod     - Incident wave kinematics model {0: none=still water, 1: plane progressive (regular), 1P#: plane progressive with user-specified phase, 2: JONSWAP/Pierson-
Moskowitz spectrum (irregular), 3: White noise spectrum, 4: user-defined spectrum from routine UserWaveSpcTrm (irregular), 5: GH Bladed wave data [option 5 is invalid for HasWAMIT = TRUE]
0          WaveStMod    - Model for stretching incident wave kinematics to instantaneous free surface {0: none=no stretching, 1: vertical stretching, 2: extrapolation stretching, ...
3630.0     WaveTMax     - Analysis time for incident wave calculations (sec) [unused when WaveMod=0] [determines WaveDOmega=2Pi/WaveTMax in the IFFT]
0.25       WaveDT      - Time step for incident wave calculations (sec) [unused when WaveMod=0] [0.1<WaveDT<=1.0 recommended] [determines WaveOmegaMax=Pi/WaveDT in the IFFT]
6.0        WaveHs      - Significant wave height of incident waves (meters) [used only when WaveMod=1, 2, or 3]
10.0       WaveTp      - Peak-spectral period of incident waves (sec) [used only when WaveMod=1 or 2]
DEFAULT    WavePkShp    - Peak-shape parameter of incident wave spectrum (-) or DEFAULT (unquoted string) [used only when WaveMod=2] [use 1.0 for Pierson-Moskowitz]
0.0        WvLowCOff   - Low cut-off frequency or lower frequency limit of the wave spectrum beyond which the wave spectrum is zeroed (rad/s) [used only when WaveMod=2, 4, or 5]
500.0      WvHiCOff    - High cut-off frequency or upper frequency limit of the wave spectrum beyond which the wave spectrum is zeroed (rad/s) [used only when WaveMod=2, 4, or 5]
0.0        WaveDir     - Incident wave propagation heading direction (degrees) [unused when WaveMod=0 or 5]
123456789  WaveSeed(1)   - First random seed of incident waves [-2147483648 to 2147483647] (-) [unused when WaveMod=0 or 5]
1011121314 WaveSeed(2)   - Second random seed of incident waves [-2147483648 to 2147483647] (-) [unused when WaveMod=0 or 5]
TRUE       WaveNDamp    - Flag for normally distributed amplitudes (flag)
""         GHWvFile     - Root name of GH Bladed files containing wave data (quoted string) [used only when WaveMod=5]
9          NWaveElev    - Number of points where the incident wave elevations can be computed (-) [maximum of 9 output locations]
0.0, 0.0, 0.0, 10.0, 10.0, 10.0, -10.0, -10.0, -10.0 WaveElevxi - List of xi-coordinates for points where the incident wave elevations can be output (meters ...
0.0, 10.0, -10.0, 0.0, 10.0, -10.0, 0.0, 10.0, -10.0 WaveElevyi - List of yi-coordinates for points where the incident wave elevations can be output (meters ...
----- CURRENT -----
0          CurrMod     - Current profile model {0: none=no current, 1: standard, 2: user-defined from routine UserCurrent} (switch)
0.0        CurrSSV0    - Sub-surface current velocity at still water level (m/s) [used only when CurrMod=1]
DEFAULT    CurrSSDir   - Sub-surface current heading direction (degrees) or DEFAULT (unquoted string) [used only when CurrMod=1]
20.0       CurrNSRef   - Near-surface current reference depth (meters) [used only when CurrMod=1]
0.0        CurrNSV0    - Near-surface current velocity at still water level (m/s) [used only when CurrMod=1]
0.0        CurrNSDir   - Near-surface current heading direction (degrees) [used only when CurrMod=1]
0.0        CurrDIV     - Depth-independent current velocity (m/s) [used only when CurrMod=1]
0.0        CurrDIDir   - Depth-independent current heading direction (degrees) [used only when CurrMod=1]
----- FLOATING PLATFORM -----
FALSE      HasWAMIT     - Using WAMIT (flag)
""         WAMITFile    - Root name of WAMIT output files containing the linear, nondimensionalized, hydrostatic restoring matrix (.hst extension), frequency-dependent ...
1.0        WAMITULEN    - Characteristic body length scale used to redimensionalize WAMIT output (meters)
8029.21    PtfmVol0     - Displaced volume of water when the platform is in its undisplaced position (m^3) [USE THE SAME VALUE COMPUTED BY WAMIT AS OUTPUT IN THE .OUT FILE!]
0.0        PtfmCOBxt   - The xt offset of the center of buoyancy (COB) from the platform reference point (meters)
0.0        PtfmCOByt   - The yt offset of the center of buoyancy (COB) from the platform reference point (meters)
1          RdtnMod     - Radiation memory-effect model {0: no memory-effect calculation, 1: convolution, 2: state-space} (switch) [STATE-SPACE REQUIRES *.ss INPUT FILE]
60.0       RdtnTMax     - Analysis time for wave radiation kernel calculations (sec) [determines RdtnDOmega=Pi/RdtnTMax in the cosine transform] [MAKE SURE THIS IS LONG ENOUGH ...
0.025      RdtnDT      - Time step for wave radiation kernel calculations (sec) [DT<=RdtnDT<=0.1 recommended] [determines RdtnOmegaMax=Pi/RdtnDT in the cosine transform]

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```

----- FLOATING PLATFORM FORCE FLAGS -----
True      PtfmSgF    - Platform horizontal surge translation force (flag) or DEFAULT
True      PtfmSwF    - Platform horizontal sway translation force (flag) or DEFAULT
True      PtfmHvF    - Platform vertical heave translation force (flag) or DEFAULT
True      PtfmRF     - Platform roll tilt rotation force (flag) or DEFAULT
True      PtfmPF     - Platform pitch tilt rotation force (flag) or DEFAULT
True      PtfmYF     - Platform yaw rotation force (flag) or DEFAULT
----- FLOATING PLATFORM ADDITIONAL STIFFNESS AND DAMPING -----
0.0  0.0  0.0  0.0  0.0  0.0  AddF0    - Additional preload (N, N-m)
0.0  0.0  0.0  0.0  0.0  0.0  AddCLin  - Additional linear stiffness (N/m, N/rad, N-m/m, N-m/rad)
0.0  0.0  0.0  0.0  0.0  0.0
0.0  0.0  0.0  0.0  0.0  0.0
0.0  0.0  0.0  0.0  0.0  0.0
0.0  0.0  0.0  0.0  0.0  0.0
0.0  0.0  0.0  0.0  0.0  0.0
0.0  0.0  0.0  0.0  0.0  0.0  AddBLin  - Additional linear damping(N/(m/s), N/(rad/s), N-m/(m/s), N-m/(rad/s))
0.0  0.0  0.0  0.0  0.0  0.0
0.0  0.0  0.0  0.0  0.0  0.0
0.0  0.0  0.0  0.0  0.0  0.0
0.0  0.0  0.0  0.0  0.0  0.0
0.0  0.0  0.0  0.0  0.0  0.0  AddBQuad - Additional quadratic drag(N/(m/s)^2, N/(rad/s)^2, N-m(m/s)^2, N-m/(rad/s)^2)
0.0  0.0  0.0  0.0  0.0  0.0
0.0  0.0  0.0  0.0  0.0  0.0
0.0  0.0  0.0  0.0  0.0  0.0
0.0  0.0  0.0  0.0  0.0  0.0
----- HEAVE COEFFICIENTS -----
6      NHvCoef    - Number of heave coefficients (-)
HvCoefID  HvCd      HvCa
(-)      (-)      (-)
1      0.8      0.9
2      0.9      0.9
3      1.0      0.9
4      0.8      1.0
5      0.9      1.0
6      1.0      1.0
----- MEMBER JOINTS -----
5      NJoints    - Number of joints (-) [must be exactly 0 or at least 2]
JointID  Jointx    Jointy    Jointz    JointHvID  JointOvrIp  [JointOvrIp= 0: do nothing at joint, 1: eliminate overlaps by calculating super member]
(-)      (m)      (m)      (m)      (-)      (switch)
1      0.0      0.0      5.0      1      0
2      0.0      0.0      -20.0     2      0
3     -10.0     -10.0     -50.0     4      0
4     13.66     -3.66     -50.0     6      0
5     -3.66     13.66     -50.0     3      0
----- MEMBER CROSS-SECTION PROPERTIES -----
2      NPropSets   - Number of member property sets (-)
PropSetID  PropD      PropThck

```

```

(-)      (m)      (m)
1        6.5      0.04
2        4.5      0.05
----- SIMPLE HYDRODYNAMIC COEFFICIENTS (model 1) -----
SimplCd   SimplCdMG   SimplCa   SimplCaMG
(-)      (-)      (-)      (-)
0.60     1.05      0.6      1.0
----- DEPTH-BASED HYDRODYNAMIC COEFFICIENTS (model 2) -----
2          NCoefDpth      - Number of depth-dependent coefficients (-)
Dpth      DpthCd   DpthCdMG   DpthCa   DpthCaMG
(m)      (-)      (-)      (-)      (-)
-20     .2      .3      .5      .7
-50     .3      .35     .55     .75
----- MEMBER-BASED HYDRODYNAMIC COEFFICIENTS (model 3) -----
1          NCoefMembers      - Number of member-based coefficients (-)
MemberID   MemberCd1   MemberCd2   MemberCdMG1   MemberCdMG2   MemberCa1   MemberCa2   MemberCaMG1   MemberCaMG2
(-)      (-)      (-)      (-)      (-)      (-)      (-)      (-)      (-)
3        .2      .3      .25     .4      .6      .7      .65     .75
----- MEMBERS -----
4          NMMembers      - Number of members (-)
MemberID   MJointID1   MJointID2   MPropSetID1   MPropSetID2   MDivSize   MCoefMod   PropWAMIT   [MCoefMod=1: use simple coeff table, 2: use depth-based coeff table, 3: use member-based ...
(-)      (-)      (-)      (-)      (-)      (m)      (switch)   (flag)
1        1        2        1        2        10      1        false
-2       2        3        2        2        10      2        false
3        2        4        2        2        10      3        false
4        2        5        2        2        10      1        false
----- FILLED MEMBERS -----
1          NFillGroups      - Number of filled member groups (-) [If FillDens = DEFAULT, then FillDens = WtrDens; FillFSLoc is related to MSL2SWL]
FillNumM   FillMList      FillFSLoc   FillDens
(-)      (-)      (m)      (kg/m^3)
1        4      -20      1010
----- MARINE GROWTH -----
2          NMGDepths      - Number of marine-growth depths specified (-)
MGDpth     MGThck     MGDens
(m)      (m)      (kg/m^3)
-30     .01      1100
-45     .004     1300
----- MEMBER OUTPUT LIST -----
2          NMOutputs      - Number of member outputs (-) [must be < 10]
MemberID   NOutLoc   NodeLocs [NOutLoc < 10; node locations are normalized distance from the start of the member, and must be >=0 and <= 1] [unused if NMOutputs=0]
(-)      (-)      (-)
1        9      0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9
3        3      0.05 0.5 1.0
----- JOINT OUTPUT LIST -----
2          NJOutputs      - Number of joint outputs (-) [Must must be < 10 ]
4 2        JOutList      - List of JointIDs which are to be output (-)[unused if NJOutputs=0]
----- OUTPUT -----
True      HDSum      - Output a summary file [flag].
False     OutAll     - Output all user-specified member and joint loads (only at each member end, not interior locations) [flag]

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1          OutSwTch      - Output requested channels to: [1=Hydrodyn.out, 2=GlueCode.out, 3=both files]
"ES11.4e2" OutFmt       - Output format for numerical results (quoted string) [not checked for validity!]
"A11"      OutSFmt      - Output format for header strings (quoted string) [not checked for validity!]
----- FLOATING PLATFORM OUTPUTS -----
"Wave1Elev"                                     - Wave elevation at ( 0, 0)
"Wave2Elev"                                     - Wave elevation at ( 0, 10)
"Wave3Elev"                                     - Wave elevation at ( 0,-10)
"Wave4Elev"                                     - Wave elevation at ( 10, 0)
"Wave5Elev"                                     - Wave elevation at ( 10, 10)
"Wave6Elev"                                     - Wave elevation at ( 10,-10)
"Wave7Elev"                                     - Wave elevation at (-10, 0)
"Wave8Elev"                                     - Wave elevation at (-10, 10)
"Wave9Elev"                                     - Wave elevation at (-10,-10)
"WavesFxi , WavesFyi , WavesFzi , WavesMxi , WavesMyi , WavesMzi" - Longitudinal, lateral, and vertical wave-excitation forces and moments at the platform reference point
"HdrStcFxi, HdrStcFyi, HdrStcFzi, HdrStcMxi, HdrStcMyi, HdrStcMzi" - Longitudinal, lateral, and vertical hydrostatic forces and moments at the platform reference point
"RdtnFxi , RdtnFyi , RdtnFzi , RdtnMxi , RdtnMyi , RdtnMzi" - Longitudinal, lateral, and vertical radiation memory effect forces and moments at the platform reference point
END of Floating platform outputs
----- MESH-BASED OUTPUTS -----
"M2N2FVxi , M2N2FVyi , M2N2FVzi"               - Longitudinal, lateral, and vertical wave particle velocities at output member 2 and output node location 2
"M2N2FAxi , M2N2FAyi , M2N2FAzi"               - Longitudinal, lateral, and vertical wave particle accelerations at output member 2 and output node location 2
"M2N2FDxi , M2N2FDyi , M2N2FDzi"               - Longitudinal, lateral, and vertical drag forces at output member 2 and output node location 2
"M2N2FIxi , M2N2FIyi , M2N2FIzi"               - Longitudinal, lateral, and vertical inertial forces at output member 2 and output node location 2
"M2N5FDxi"                                     - Longitudinal, lateral, and vertical drag forces at output joint 1
"J1FDxi , J1FDyi , J1FDzi "                   - Longitudinal, lateral, and vertical drag forces at output joint 1
END of mesh-based outputs and HydroDyn input file (the word "END" must appear in the first 3 columns of this last line).

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