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A Computer Progam for the Design of Taut Subsurface Moorings

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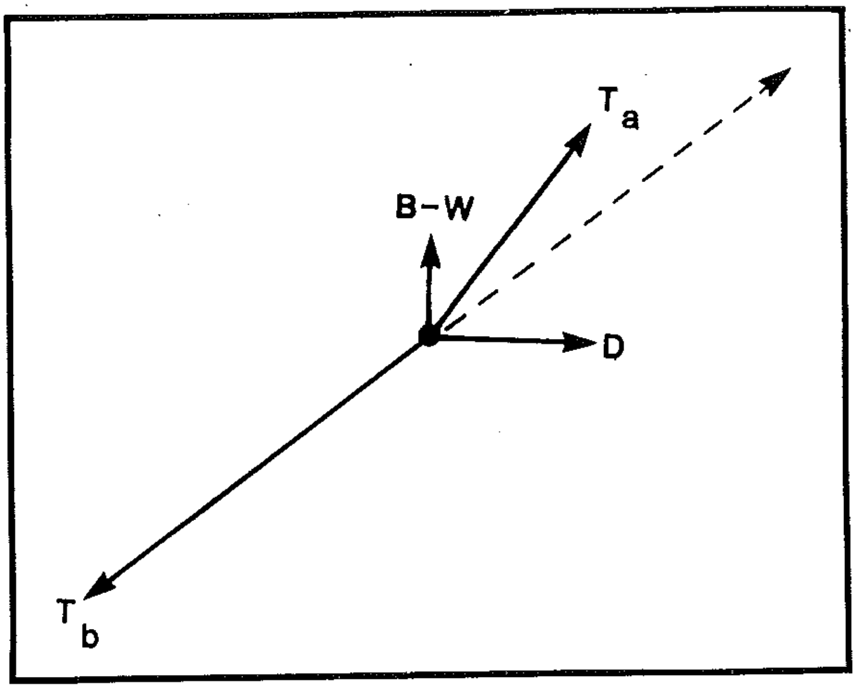

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ABSTRACT

A computer program for the static analysis of a current meter mooring has been developed to help oceanographers design high performance mooring systems with Gulf Stream applications particularly in mind.

The special features of the analysis are:

1. Mooring components characteristics and current profiles are input parameters which can be modified by the user easily.

2. During the launch while the anchor pulls the mooring to the bottom, the transient tensions on each mooring component and their maximum sink rates are estimated; this analysis is done with and without a parachute attached to the anchor to slow the descent and reduce tensions.

3. The equilibrium performance with the anchor resting on the sea floor is computed to list the working tensions, tilt angles and depths for each mooring component. The component depth estimates account for the tilt, the elastic stretch of the line under working tension, and permanent stretch of the line under launch tensions, and hence this analysis is also done for the parachute and no-parachute cases.

4. Warnings are printed if the buoyancy is not distributed in such a way that, even if any line element were to break in the mooring, all parts above the release would nevertheless float to the sea surface.

5. Cost analysis of the mooring design is included.

6. The program displays the total horizontal drag felt by the anchor, to test whether it would drag.

This report specifically documents current meter mooring design for moorings launched November 1986 in the Gulf Stream off Cape Hatteras in a SYNOP (Synoptic Ocean Prediction) Pilot Experiment. It describes in detail how to evaluate the computer program solution.

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1.0 INTRODUCTION

A Fortran 77 program, which can be run on the Prime computer system at the Narragansett Bay Campus of the University of Rhode Island, has been developed to determine the equilibrium static configuration of subsurface moorings. The program treats the mooring system as a set of discrete elements. It takes all the buoyancy and the drag as if concentrated at a few points along the mooring line.

It is the intent of this report to describe a simplified technique which evaluates the performance of a mooring system by predicting its static response.

The procedures for similar but more complex analysis have been described in a series of articles by Berteaux and Chhabra (1973), Berteaux (1976), and Moller (1976), on which much of the following work is based. In this new program, however, several simplifying assumptions have been made to expedite the engineering choices to be made in designing a restricted class of moorings: The mooring will be assumed to have sufficient buoyancy that its various components only tilt through small angles, and this allows some simplifying assumptions, described later. Moreover, the current profile is taken to be unidirectional to estimate the "worst case" tilt angles and vertical deflections for a given profile, and hence the analysis is all in one plane.

The focus and intent of our treatment has been to quickly and simply obtain engineering criteria for a safe design of taut subsurface moorings that have minimal vertical excursion of their components. For this purpose, given a current profile, and mooring configuration, the program output gives several things one wants to know: tensions on each component during launch and while in place, the vertical excursions on each component and their tilt angles, the total drag upon the anchor, whether buoyancy is safely distributed, and other factors.

More sophisticated and general programs which are in the above references are presumably better at exactly mimicking mooring performance in a wider range of situations. For design considerations where the above assumptions apply, this program should be adequate, and we show good agreement with observations in one example drawn from an earlier deployment.

2.0 OBJECTIVES

A. A specific objective of this report is to document the moorings designed for the ONR sponsored Pilot Experiment of SYNOP (<u>Syn</u>optic <u>O</u>cean <u>P</u>rediction), conducted November 1986 - March 1987 in the Gulf Stream off Cape Hatteras, North Carolina.

B. To test the reliability and usefulness of the program, the program predicted performance is compared with an earlier similar set of moorings deployed in 1984-85 in the Gulf Stream.

3.0 THEORIES AND METHODS

In determining the final equilibrium position of the mooring and other design considerations, the following factors are considered:

a. Component buoyancy-minus-weight and physical length

b. Normal drag factor

c. Tangential drag factor

d. Depth of water

e. Horizontal current speed profile

f. Launch tensions

g. Elastic properties of wires and synthetic lines

h. Anchor weight in water

i. Component cost

The computer program places each discrete segment of the mooring in a horizontal current velocity field which for simplicity is taken to be unidirectional, but may vary with depth. The static analysis in the vertical plane assumes that the mooring has enough buoyancy to remain "nearly" vertical, so that mooring components remain within the same current and do not tilt enough to significantly change their drag area presented normal to the current.

The user supplies the necessary component characteristics (Appendix B) and the velocity profile (Appendix C) to be used by the program. The user specifies the segment length in the control file for different components. The buoyancy and drag forces are calculated and used to determine the inclination of each segment. The program calculates the accumulated buoyancy-minus-weight, drag, and vertical displacement due to tilt, permanent and elastic elongations resulting as the segment is stretched during launch and after equilibrium position is attained. The equilibrium position of each segment and its tension are finally calculated using a simplified, non-iterative method.

In addition to a cost analysis, the program provides a launch transient analysis which supplies information about velocities and launch tensions experienced by each segment of the mooring before they reach the equilibrium position.

3.1 Launch Performance

An analysis of the launch transient is done with and without the use of a parachute attached to the anchor weight to slow its descent. Just before launch, the mooring lies along the sea surface and the anchor is the last thing launched, drawing the mooring down to the sea floor. The tensions and the velocities experienced by each component of the mooring during free-fall anchor descent are calculated. This analysis provides information that helps ensure a safe launching of the mooring as well as the required stress information for calculating the permanent elongations of the line components.

Figure 1 illustrates the force balances for a portion of the mooring sinking through the water. For simplicity, we only consider the vertical components of force, with the following balance:

$$T_k = -\{ \sum_{i>k}(B-W) + (\sum_{i>k} K_D)V^2 \}$$

where

T_k = tension in the kth component in pounds

$\sum_{i>k}(B-W)$ = sum of buoyancy-minus-weights of all the components below the kth component

$\sum_{i>k} K_D$ = sum of the vertical drag factors of all components below the kth component

V = vertical sinking velocity of the mooring in cm/s

and

$$K_D = \frac{1}{2} \rho \, C_{DV} \, A \, N$$

where ρ = mass density, taken to be 1 gram/cm^3

C_{DV} = vertical drag coefficient of the component

A = effective area of the component

N = unit conversion constant, taken to be 0.224×10^{-5} pounds/dyne

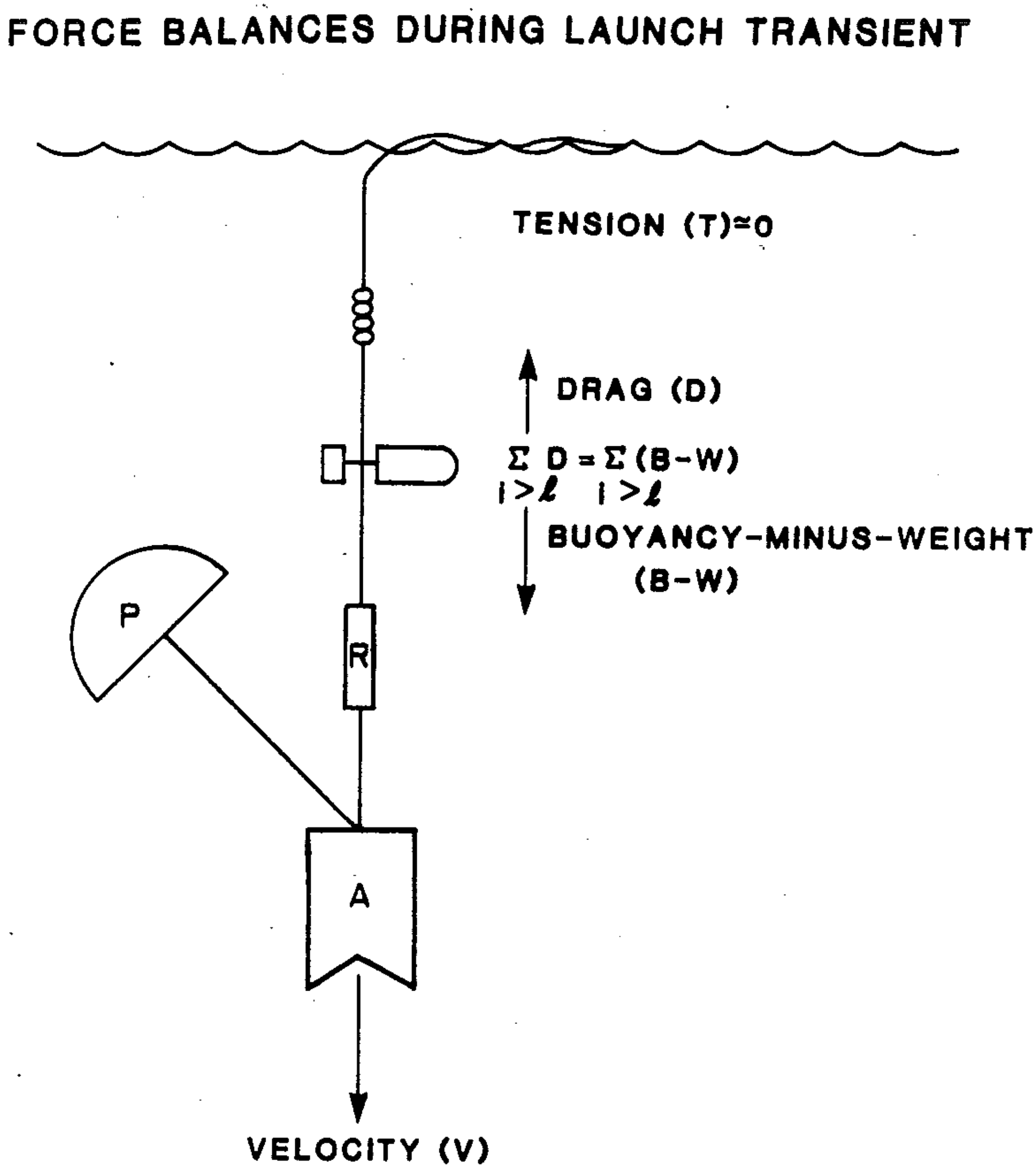


Figure 1. Schematic diagram of vertical force balance when several mooring components have been drawn below the surface during launch. The anchor (A), parachute (P), and release (R) are indicated. However, the line lengths are just schematic: the parachute would not be allowed to extend up to the release, where it might tangle.

As each successive component is drawn below the sea surface it must be included in the above summations. At the sea surface we take the vertical component of the tension to be zero. Hence the velocity of the k^{th} component to be drawn below the surface is found as:

$$V_k^2 = \frac{-\sum\limits_{i>k}(B-W)}{\sum\limits_{i>k} K_D}$$

where

$\sum\limits_{i>k}(B-W)$ = sum of buoyancy-minus-weights of all the components below the kth component

$\sum\limits_{i>k} K_D$ = sum of the vertical drag factors of all the components below the kth component

In this way, the sinking velocity of the top and last element of the mooring calculated is equal to the terminal velocity of the whole mooring. The rate of sinking decreases as more buoyancy and drag elements get drawn below the sea surface, and is slowest after this last element sinks. The tensions are highest when the vertical velocity is lowest, because this reduces the drag on the anchor and parachute.

3.2 Equilibrium Static Force Balances

When the mooring anchor has reached the ocean bottom, the static forces involve vertically the buoyancies and weights of each component, and horizontally the drags arising from the horizontal currents. These forces are balanced by the line tensions and ultimately at the bottom by the anchor weight and its frictional resistance to dragging across the bottom. Elements at the top of the mooring are lumped into a sum of buoyancy-minus-weight and drag components held in static equilibrium by the line tension (see Figure 2a). The vector force balance is as follows:

$$\underline{T}_1 = - [(\underline{B-W})_1 + \underline{D}_1]$$

Each successive element m just has the tension below T_b balance the tension above T_a plus the additional buoyancy-minus-weight and drag at that element (see Figure 2b).

STATIC FORCE BALANCES FOR TOP ELEMENT

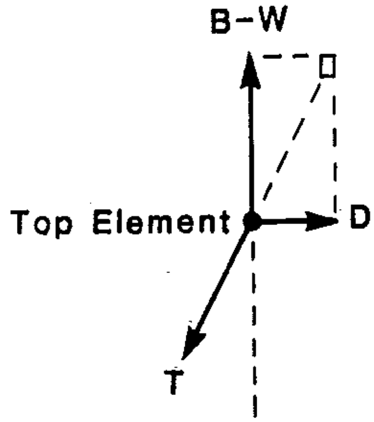


Figure 2a.

STATIC FORCE BALANCES AT EACH ELEMENT

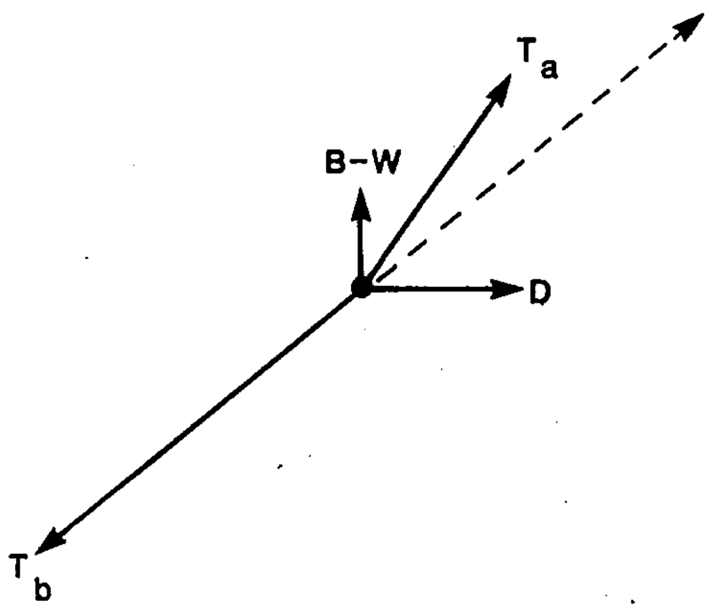


Figure 2b.

$$T_b = -[T_a + (B-W)_m + D_m]$$

$$= -\sum_{i \le m} (B_i - W_i) + D_i$$

where the sums are over everything at and above element m.

Thus at each element, the tension in the line below it just vectorially balances all the buoyancy-minus-weight and drag at and above it.

3.3 Anchor Resistance to Dragging

At the bottom, the anchor weight and static bottom friction must be adequate to resist the vectorial tension of everything above it: (see figure 3)

This requires that

$W_a > \Sigma (B_i - W_i)$ + amount needed for friction

$$F_a = \mu[W_a - \Sigma(B-W)_i] > \Sigma D_i$$

where μ = coefficient of static friction (0.75 is used for the MACE anchor in mud).

Therefore the required weight of the anchor in water is

$$W_a > 1.33 \cdot \Sigma D + \Sigma(B-W)$$

3.4 Segment Displacement

At any element m, the angle of the mooring line below it is:

$$\theta_m = \tan^{-1} \{\sum_{i \le m} D_i \Big/ \sum_{i \le m} (B_i - W_i)\}$$

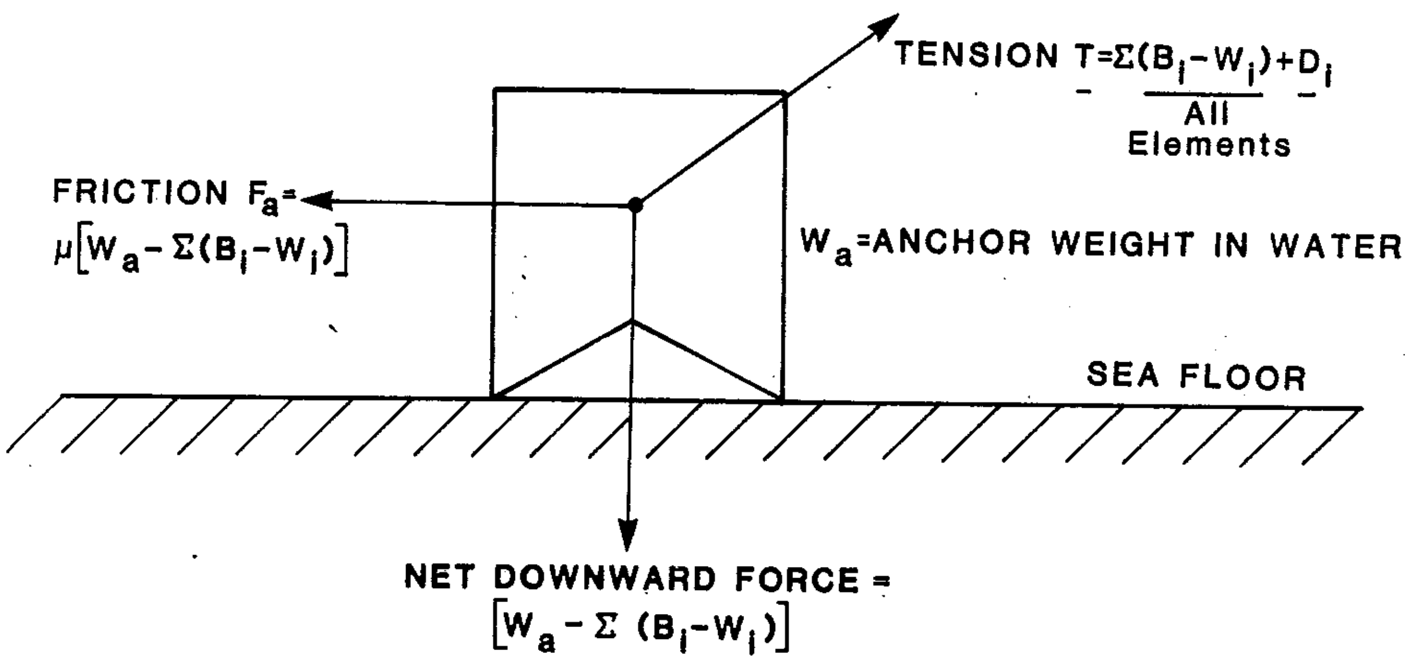
where the sums are over everything at and above element m

The line tension magnitude is:

$$T_m = \{ [\sum_{i \le m} (B_i - W_i)]^2 + [\sum_{i \le m} D_i]^2\}^{1/2}$$

where the sums are over everything at and above element m

Figure 3. FORCE DIAGRAM FOR ANCHOR STABILITY



The actual vertical distance spanned by the j^{th} line segment is less than the length h_i of the segment by (see Figure 4)

$$\delta h_i = h_i(1-\cos\theta)$$

Hence the net amount by which an element is depressed is the sum of all the δh_i of the elements below it:

$$\Delta h_i = \sum_{\substack{\text{all} \\ \text{below } i \\ (k>i)}} \delta h_k = \sum_{\substack{\text{all} \\ \text{below } i \\ (k>i)}} h_k(1-\cos\theta_k)$$

3.5 Current Profiles

The drag forces on the mooring line are due to horizontal currents. For these Gulf Stream applications, three vertical profiles of current speed have been used. (see Appendix C), including a profile of "typical' current speeds, one of "strong" current speeds, and an "extreme" profile of currents. All are taken to be unidirectional, which for a given set of speeds would cause the greatest tilt from vertical and the greatest vertical displacement. The "typical" and "strong" profiles were taken from Halkin and Rossby's (1985) set of Pegasus profiles taken in the Gulf Stream in 19 sections during a three year period. The "extreme" profile is a composite of all the highest observed speeds at each depth from several current meter records and the Pegasus profiles; never were those extreme cases all simultaneously present. The greatest distinction between the three profiles is in the deep water (Figure 8).

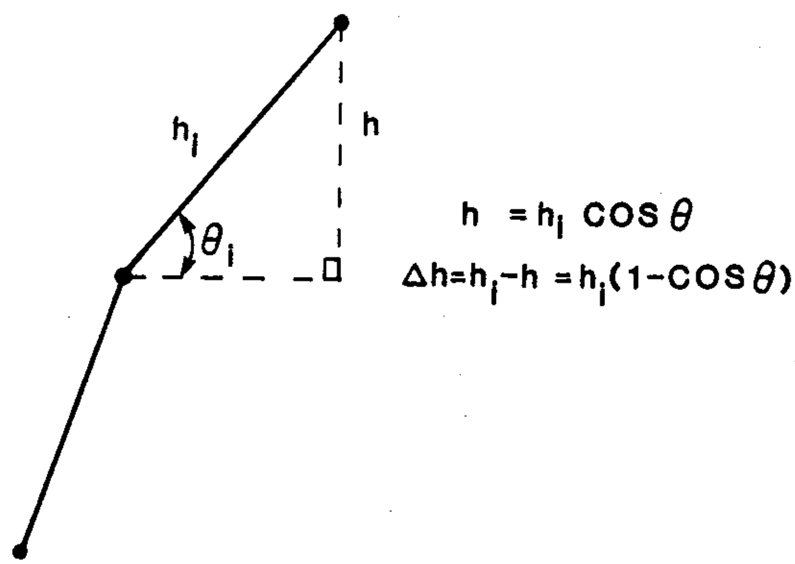
3.6 Elastic Properties of Components

Both the wire rope and synthetic lines have permanent and elastic elongations under the high tensions in these moorings. This elongation counteracts the vertical displacement due to mooring tilt. The program accounts for these elongations by the following approximations, derived from data and formulae in Berteaux,1976 and Chhabra and Berteaux,1973.

For both synthetic line and wire rope, the total elongation of each segment of the line due to both permanent and elastic responses is approximated by:

$$\frac{\delta L_i}{L_i} = C_p \cdot T_{iL} + C_e \cdot T_{iE}$$

Figure 4. INCLINATIONS OF MOORING LINE



where

δL_i = total strain or elongation (meters)

L_i = measured length of the segment (meters) (at original 200 D^2 tension, in pounds, where D is the diameter in inches)

T_{iL} = maximum tension in the segment during launch (pounds)

T_{iE} = working tension in the segment in equilibrium (pounds)

C_p = permanent stretch coefficient ($pound^{-1}$)

C_e = elastic stretch coefficient ($pound^{-1}$)

For the wire rope, the permanent stretch coefficient is found by:

$$C_p = \frac{K}{RBS}$$

where

K = coefficient of structural stretch of wire (constant) (Moller,1976)

RBS = rated breaking strength of the wire (pounds)

and the elastic stretch coefficient is found by:

$$C_e = \frac{1}{A \cdot E}$$

where

A = cross-sectional area of the metallic wire ($inch^2$)

E = modulus of elasticity (psi)

For the synthetic lines, the permanent stretch coefficien is found by approximating the characteristic curve of the synthetic line by a straight line from the origin to the point with tension equal to 50% of the rated breaking strength (RBS) of the line, a tension that we avoid exceeding during the launch. (See figure 5a, taken from Berteaux,1973)

Since

$$C_p = \frac{\delta L/L}{T} \qquad \text{by definition,}$$

where $\delta L/L$ = the ordinate of the characteristic permanent elongation curve in %

T = 50% of the RBS of the synthetic line

therefore,

$$C_p = \frac{1}{100 \cdot m \cdot D^2}$$

where

m = slope of the straight line obtained in approximation
D = diameter of the synthetic line

The elastic stretch coefficient is determined in a similar manner except in the approximation procedure, the point on the characteristic curve with tension T = 30% of RBS is taken instead of that with tension T = 50% of RBS. This gives a better approximation, because we design to avoid exceeding 30% RBS as a working tension in the mooring. (See figure 5b, taken from Berteaux,1973)

3.7 Reserve Buoyancy

For each set of floatation elements, the weights of all the mooring components between the adjacent two sets of floatation above and below, are added up to determine the amount of reserve buoyancy needed. The mooring is designed with distributed buoyancy elements to have adequate reserve buoyancy to recover sub-portions of the mooring in case any of the lines break. The total weight must not exceed the amount of floatation between elements. The reserve buoyancy calculation is done with all components from the top to the release. Components below the release are not recoverable.

3.8 Cost Analysis

The cost analysis gives an estimate of the total cost of the mooring design. The cost of each element of the mooring is supplied to the program through the control file as described in appendix B. The program reads in the cost per meter of the line elements to calculate the cost for different lengths used. The cost

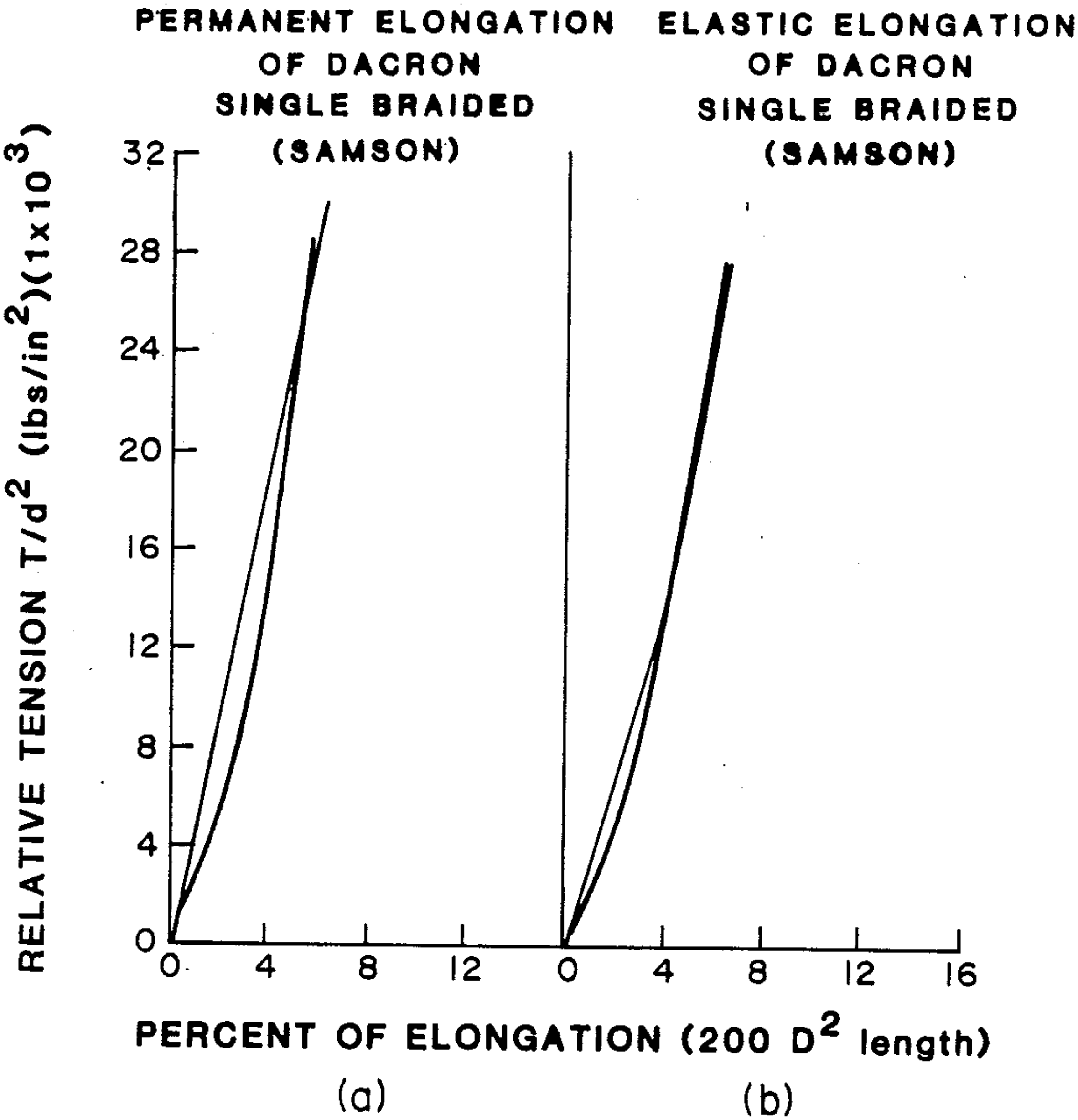

PERMANENT ELONGATION
OF DACRON
SINGLE BRAIDED
(SAMSON)
ELASTIC ELONGATION
OF DACRON
SINGLE BRAIDED
(SAMSON)
RELATIVE TENSION T/d2 (lbs/in2)(1x103)
32
28
24
20
16
12
8
4
0
0
4
8
12
0
4
8
12
16
PERCENT OF ELONGATION (200 D2 length)
(a)
(b)

Figure 5.

per unit component is read in to calculate the total cost for other components of the mooring.

4.0 SAMPLE DESIGN CONFIGURATION

4.1 Summary of Design Analysis and Modification

Among the many factors to be considered when designing a current meter mooring, we particularly check the following outputs of this program:

A. During the launch, the transient tensions experienced by each component during launch should not exceed some acceptable fraction of its own rated breaking strength (see Table 1). Those tensions would be highest if the parachute failed (the no-parachute case). The velocities of the sinking instruments should be within acceptable limits, for instance so that the current meter rotors do not get blown out. In general, sinking velocities should not exceed 400 cm/s.

B. After the mooring has reached its equilibrium position, with the anchor on the sea floor, the tensions in the line/element components should not exceed the working load suggested by the manufacturers. In these moorings, we designed for the maximum working tensions not to exceed 30% RBS for dacron line and 50% RBS for jacketed wire rope.

C. The total vertical displacement of the mooring and the tilting angles or inclinations of the current meters on the mooring should stay below the following limits. In order to put a large safety factor in the design, the displacements of the mooring in the extreme current velocity profile are checked to see that all mooring components can withstand the added pressures. The inclinations in the strong current velocity profile are considered to see that the current meters will perform satisfactorily (usually <26 degrees for Aanderaa current meters and <15 degrees for VACM (Vector Averaging Current Meter)). (The different current velocity profiles are discussed in section 3.5)
The faired wire is found to produce an amount of drag (see Table 2) which is approximately 1/2 to 1/3 of that produced by the unfaired wire rope of the same size at the same current velocity. For this reason, the faired wire is very useful in minimizing the inclinations of the mooring. The fairing is most effective when it is used at the shallow depths where there is a relatively higher water current speed.

D. The final depths of the different current meters are affected

Table 1

RATED BREAKING STRENGTHS

TYPE of LINE ELEMENT	DIAMETER SIZE (inch)	RATED BREAKING STRENGTH (pound)
BRAIDED DACRON (SAMSON)	1/2	13,000
BRAIDED DACRON (SAMSON)	9/16	15,600
BRAIDED NYLON	3/4	18,400
WIRE ROPE (MAC WLYTE)	3/16	4,000
CHAIN	3/8	16,200
CHAIN	1/2	27,600
SPINDLE ROD of AANDERAA CURRENT METERS	—	10,340

Table 2

NORMAL DRAG FACTORS and EFFECTIVE AREAS NORMAL to CURRENT of the MOORING COMPONENTS

COMPONENT	DRAG FACTOR (C_D)	EFFECTIVE AREA NORMAL to CURRENT (A)
SYNTACTIC FLOAT (60 inch diameter)	0.5	18242 cm^2
JACKETED WIRE (3/16") (0.329 inch diameter)	1.5	84 cm^2 per meter
FAIRED WIRE (3/16") (0.650 inch diameter)	0.3	152 cm^2 per meter
CHAIN (3/8 inch diameter)	1.3	381 cm^2 per meter
DACRON (9/16 inch diameter)	1.5	143 cm^2 per meter
NYLON (3/4 inch diameter)	1.5	190 cm^2 per meter
AANDERAA CURRENT METERS (aacm)	1.2	750 cm^2
GLASS SPHERE (17 inch diameter)	0.8	1464 cm^2
RELEASE	1.2	2916 cm^2

Table 3

PERMANENT AND ELASTIC ELONGATION COEFFICIENTS OF WIRE ROPES AND SYNTHETIC LINES

TYPE of LINE	DIAMETER SIZE (inch)	PERMANENT ELONGATION COEFFICIENT (C_P) ($pound^{-1} \times 10^{-6}$)	ELASTIC ELONGATION COEFFICIENT (C_E) ($pound^{-1} \times 10^{-6}$)
BRAIDED DACRON (SAMSON)	1/2	13.50	18.00
BRAIDED DACRON (SAMSON)	9/16	10.68	14.22
BRAIDED NYLON	3/4	22.83	34.60
WIRE (MAC WLYTE)	3/16	3.21	1.77

Table 4

COMPARISON OF PREDICTED VERSUS OBSERVED PERFORMANCE

	DEPTH of CURRENT METER FROM PRESSURE RECORD DATA (meters)	PREDICTED DEPTH of CURRENT METER by PROGRAM (meters)
ZERO CURRENT	300	296
TYPICAL CURRENT PROFILE	430	437
STRONG CURRENT PROFILE	590	489
EXTREME CURRENT PROFILE	—	733

not only by the tilt angles but also by the elastic properties of the wire ropes and synthetic lines (see section 3.6). Both the wire ropes and the synthetic lines have permanent and elastic elongations due to the tensions they experience during launch and after the equilibrium position has been attained. A permanent elongation coefficient and an elastic elongation coefficient are determined for each kind of wire rope and synthetic line (see Table 3). The final line lengths are chosen so that the current meters will be at their target depths in the "typical" velocity profile.

E. We try to keep the total drag experienced by the anchor to be less than 3/4 of the the total buoyancy minus weight on the anchor because we estimate the frictional coefficient at the bottom of the sea is approximately 3/4 (see section 3.3).

F. The program gives a warning when there is inadquate backup buoyancy for retrieval (see section 3.7). This enables us to ensure that if the mooring breaks at any point in an accident, all the expensive instruments and data will have enough floatation to get to the surface.

4.2 Description of the Mooring Design Product and the Predicted Mooring Performance

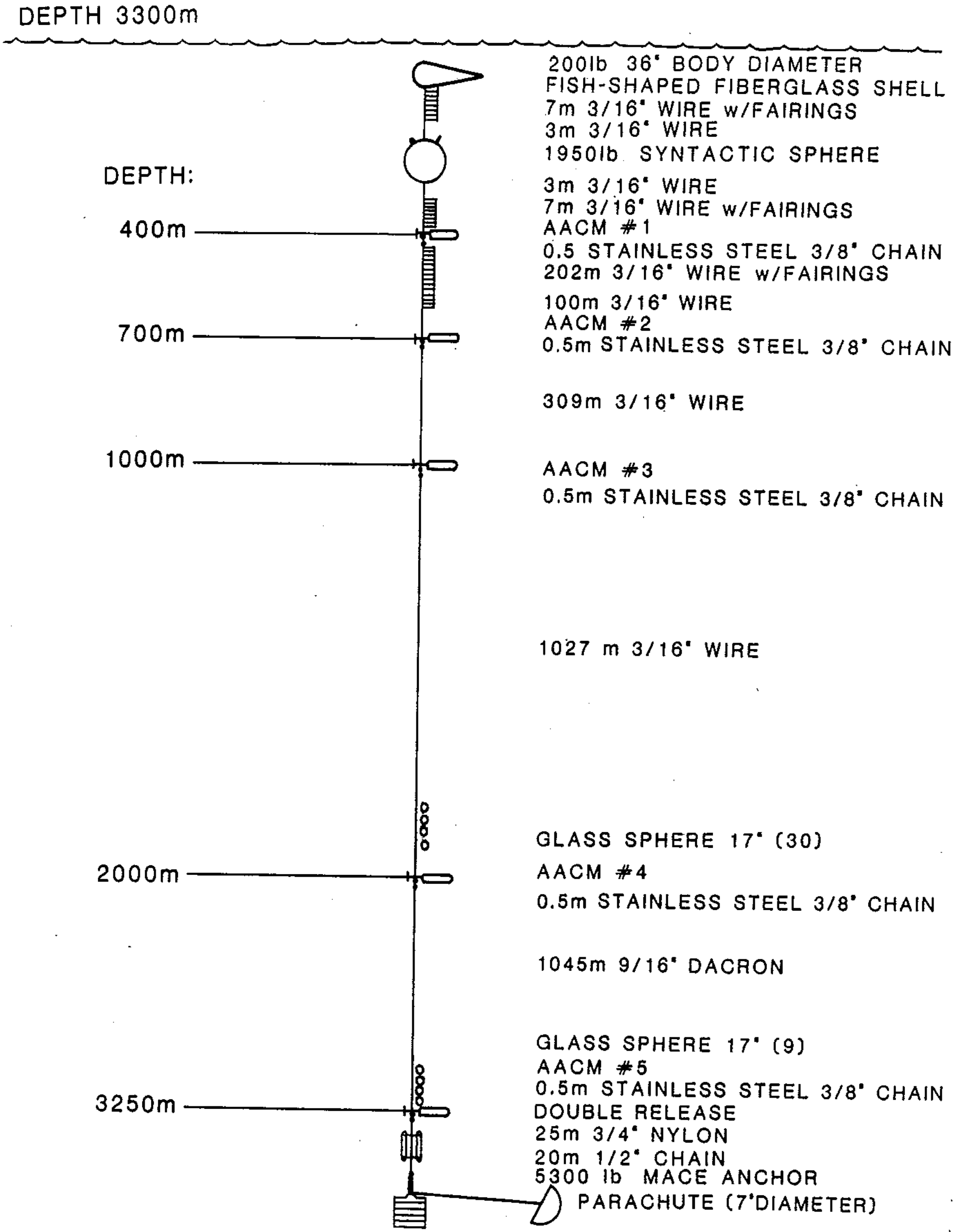
Figure 6 shows the configuration of a high performance current meter mooring system which is designed for a depth of 3300 meters. Five AANDERAA current meters (AACM) are to be positioned at target depths of 400 meters, 700 meters, 1000 meters, and 2000 meters below the surface, and 50 meters above the bottom.

All the buoyancy above 2000 meters in these moorings is provided by the large syntactic foam sphere (and the faired fish). This helps greatly to minimize the drag associated with the large amount of buoyancy on these "taut" moorings.

The major line elements used are jacketed 3/16 inch wire rope and 9/16 inch braided dacron line. Wire with fairings is used at the shallow region to minimize the drag produced on the lines. 25 meters of nylon line is used to absorb the shock during the launch transient, and an anchor of 5300 pounds (weight in water) is used to stabilize the mooring system at the bottom.

Three current velocity profiles are used to analyse the mooring performance. The performance of the mooring in an extreme current velocity profile (VELS.EXTREME, Appendix C) can be found in Appendix E(1). The tensions on all the segments are checked against the suggested working loads of the components. (For wire rope, 50% RBS is recommended, we have 53% but only for a few days until the top fish was released separately. For dacron line, 30% RBS is recommended and we have 22% RBS.) The total displacement (SUMDH) and the component depths (TRUED) are checked to be within

Figure 6. SAMPLE MOORING DESIGN



acceptable limits. (The depths are slightly greater (~3m) in the parachute launch case because the lower launch tension produces lower permanent elongation of the lines.)

Appendix E(2) shows the analysis of the mooring performance in a strong current velocity profile (VELS.STRONG) (See Appendix C). The inclinations (THETA) of the current meters are carefully studied. For the AANDERAA current meters, the inclinations are found to be all smaller than 17 degrees, which can be entirely compensated by the gimbal mount (up to 26 degrees) on its tension rod.

Appendix E(3) shows the analysis of the mooring performance in a typical current velocity profile (VELS.TYPICAL) (See Appendix C). The analysis shows that all the current meters are located such that their TRUED are the target depths (±5 meters).

The warning message about buoyancy element 44 can be safely ignored for this mooring since it is attached by strong chain and heavy wire rope (3/8") to the next buoyancy element, which does have adequate buoyancy to lift its own sub-segment of the mooring in case lines parted.

Appendix E(4) shows the launch transient performance of the mooring system. Comparision between the performance with and without the use of a parachute shows that the parachute helps reduce significantly the sinking velocities (VI) and the launch tensions (TFINAL) of the mooring components. For instance at the lowest AACM5, VI is 474cm/s without a parachute but only 274cm/s with a parachute , and the tensions at that level are reduced from about 5500 pounds to 5000 pounds. The tensions, in the case of a malfunction of the parachute, are checked against the elastic limits of the synthetic lines and the breaking strengths of the wire rope. The velocity of the first topmost component is the terminal velocity of the mooring system.

5.0 EVALUATION OF PREDICTED VERSUS OBSERVED PERFORMANCE

The most significant performance indicator of the computer output, once the tension and the inclination of the component are within acceptable limits, is the final equilibrium position of the different components. We compare in this section the computer predicted performance of an earlier mooring in the Gulf Stream with the performance shown by its pressure and current records. The mooring was similar to the one shown in Figure 6.

The pressure records shown in figure 7 are the data collected from a 'tall' mooring deployed in 1984-85 at site "C1". Figure 7 shows how the current velocities affect the depth of the top instrument which was originally intended to be positioned at a

TEST PROGRAM PREDICTED PERFORMANCE
C1#1

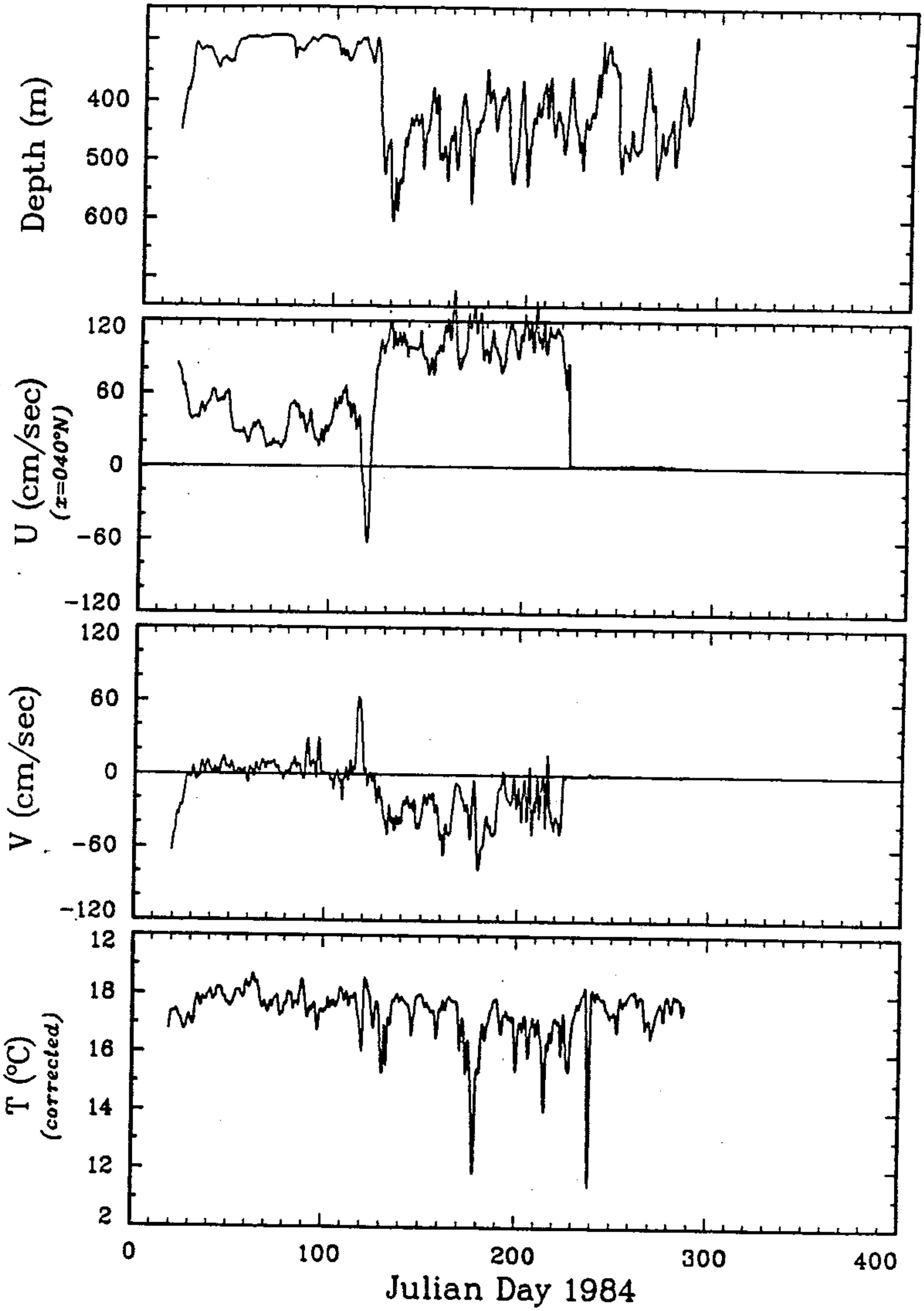


Figure 7.

depth of 500 meters. When there is no current, the instrument is at a depth of 300 meters. At a typical current profile, the instrument is at a depth of 430 meters, and in the case of a strong current profile, the instrument is at a depth of 590 meters.

The configuration of the mooring deployed was reinput into the improved mooring design program, which is the subject of this report, to compare its predictions with actual observations. Table 4 shows that the program now accurately predicts the behaviour of the mooring system in the case of zero current and a "typical" current profile. The maximum observed depth (590m) lies between the predictions generated for a "strong" current profile (489m) and for an "extreme" current profile (733m).

6.0 CONCLUSION

The simplified technique described in this report gives a reasonably good current meter mooring system analysis by treating the mooring system as a set of discrete elements and the current profile as unidirectional. The theories and methods involved in determining the static force balances and equilibrium analysis are described in detail. The program developed has been used to design a sample current meter mooring. Evaluation of the computer program solution is done by comparing the predicted mooring performance with the pressure data collected on the top instrument in an earlier experiment. This indicates that the technique used is more than adequate for engineering design of taut subsurface moorings (with inclination less than 45 degrees). For precise estimates of instrument depth-changes or for dynamic response of the mooring, one should use the more sophisticated programs.

7.0 ACKNOWLEDGEMENTS

This work is supported on U.S. Office of Naval Research contract N00014-82-C0062. Earlier versions of the computer program were developed by Karen Tracey.

8.0 REFERENCES

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2. Berteaux, H.O. and N.K. Chhabra. "Computer Programs for the Static Analysis of Single Point Moored Surface and Subsurface Buoy Systems", W.H.O.I. Report 73-22, March 1973.
3. Halkin, Daniel and T. Rossby (1985). "The Structure and Transport of the Gulf Stream at 73°W." Journal of Physical Oceanography 15, 1439-1452.
4. Moller, Donald A. "A Computer Program for the Design and Static Analysis of Single-Point Subsurface Mooring Systems: NOYFB" W.H.O.I. Report 76-59, June 1976.
5. PDR 4130-181P Prime User's Guide Rev.18.1 Prime Computer, Inc. 1980.

APPENDIX A

The Fortran program is run by executing a command input (COMINOUT) file using the PHANTOM command. (Reference 4)

The command input file specifies the name of the source program, the input control files, including the current velocity profile and the parameters control file, and the name of the output file. (Appendix B)

The following file is an example of a command input file having MOORING.86 as the source file. It reads in the VELS.TYPICAL and SET18 as input control files, and then outputs the file OUT.SET18.TYP.

```
COMO LOG.SET18
RWLOCK LOG.SET18 UPPDT
SEG MOORING.86
VELS.TYPICAL
SET18
OUT.SET18.TYP
COMO -E
LOGOUT
```

APPENDIX B

Example of mooring component parameters control file (e.g. "SET18" in Appendix A)

Column 1 (A20)	Description of component
Column 2 (I2)	Type of component 0 - Spherical or irregular element 1 - Line element
Column 3 (I2)	Number of segments the component is divided into by the program if it is line
Column 4 (I2)	Quantity of component
Column 5 (F6.0)	Target depth of component in meters
Column 6 (E12.4)	Horizontal drag coefficient in pounds/(cm/s)^2
Column 7 (F7.1)	Length of component in meters
Column 8 (F9.3)	Weight in water of component in pounds (positive weight indicates floatation element)
Column 9 (F8.2)	Cost of component in dollars
Column 10 (E11.4)	Vertical drag factor (K_D) in pounds/(cm/s)^2
Column 11 (E11.4)	Permanent elongation coefficient (C_P) in pound^{-1}
Column 12 (E11.4)	Elastic elongation coefficient (C_E) in pound^{-1}

Subsequent to completing these calculations, we have decided to change the vertical drag factors for AACM's to 7.0E-03 and for glass sphere to 1.6E-03.

1	ADCP-FISH	0 1 1	400.	2.2000E-03	0.5	200.000	0.00	6.6000E-03	0.0000E-06	0.0000E-06
2	L1 (1/4 WIRE)	1 1 1	400.	0.1420E-03	10.0	-.285	2.00	0.0106E-03	2.1190E-06	1.0000E-06
3	SYN 60	0 1 1	400.	8.1500E-03	1.5	1950.000	0.00	8.1500E-03	0.0000E-06	0.0000E-06
4	(3/16 WIRE)	1 1 1	400.	0.1140E-03	3.0	-.167	1.95	0.0087E-03	3.2060E-06	1.7670E-06
5	*(3/16 FAIR)	1 1 1	400.	0.0480E-03	7.0	-0.174	1.95	0.0270E-03	3.2060E-06	1.7670E-06
6	AACM1	0 1 1	400.	1.0100E-03	0.5	-40.000	0.00	9.8300E-03	0.0000E-06	0.0000E-06
7	L1 *(3/16 FAIR)	1 4 1	400.	0.0480E-03	186.0	-0.174	1.95	0.0270E-03	3.2060E-06	1.7670E-06
8	(3/16 WIRE)	1 2 1	600.	0.1140E-03	116.0	-.167	1.95	0.0087E-03	3.2060E-06	1.7670E-06
9	AACM2	0 1 1	700.	1.0100E-03	0.5	-40.000	0.00	9.8300E-03	0.0000E-06	0.0000E-06
10	L2 (3/16 WIRE)	1 6 1	700.	0.1140E-03	309.0	-0.167	1.95	0.0087E-03	3.2060E-06	1.7670E-06
11	AACM3	0 1 1	1000.	1.0100E-03	0.5	-40.000	0.00	9.8300E-03	0.0000E-06	0.0000E-06
12	L3 (3/16 WIRE)	110 1	1000.	0.1140E-03	1027.0	-.167	1.95	0.0087E-03	3.2060E-06	1.7670E-06
13	GLASS SPHERE	0 130	2000.	1.6000E-03	0.0	56.000	0.00	2.4600E-03	0.0000E-06	0.0000E-06
14	CHAIN (3/8)	1 1 1	2000.	0.4160E-03	30.0	-4.728	6.56	0.0540E-03	0.0000E-06	0.0000E-06
15	AACM4	0 1 1	2000.	1.0100E-03	0.5	-40.000	0.00	9.8300E-03	0.0000E-06	0.0000E-06
16	L4 (9/16 DACRON)	110 1	2000.	0.2410E-03	945.0	-.088	1.43	0.0180E-03	10.6800E-06	14.2200E-06
17	GLASS SPHERE	0 1 3	3000.	1.6000E-03	0.0	56.000	0.00	2.4600E-03	0.0000E-06	0.0000E-06
18	CHAIN (3/8)	1 1 1	3000.	0.4160E-03	3.0	-4.728	6.56	0.0540E-03	0.0000E-06	0.0000E-06
19	(3/8 WIRE)	1 1 1	3000.	0.2130E-03	22.0	-.627	7.80	0.0121E-03	0.9662E-06	0.4417E-06
20	SEDIMENT TRAP	0 1 2	3000.	5.5238E-03	0.0	-55.000	0.00	1.2264E-03	0.0000E-06	0.0000E-06
21	GLASS SPHERE	0 1 9	3000.	1.6000E-03	0.0	56.000	0.00	2.4600E-03	0.0000E-06	0.0000E-06
22	CHAIN (3/8)	1 1 1	3000.	0.4160E-03	9.0	-4.728	6.56	0.0540E-03	0.0000E-06	0.0000E-06
23	AACM5	0 1 1	3000.	1.0100E-03	0.5	-40.000	0.00	9.8300E-03	0.0000E-06	0.0000E-06
24	DOUBLE RELEASE	0 1 2	3000.	3.9200E-03	2.0	-70.000	1000.00	0.7000E-03	0.0000E-06	0.0000E-06
25	NYLON (3/4)	1 1 1	3000.	0.6250E-03	25.0	-0.062	2.54	0.0242E-03	22.8300E-06	34.6000E-06
26	CHAIN (1/2)	1 1 1	3000.	0.5550E-03	20.0	-8.081	7.87	0.0720E-03	0.0000E-06	0.0000E-06
27	ANCHOR MACE	0 1 1	3125.	0.0000E-03	0.5	-5300.000	1974.0011.8043E-03		0.0000E-06	0.0000E-06
28	PARACHUTE 7FT	0 1 1	3125.	0.0000E-03	0.0	0.000	100.0060.0660E-03		0.0000E-06	0.0000E-06

APPENDIX C

Examples of Gulf Stream velocity profiles (drawn in Figure 8)

VELS.EXTREME

VELOCITY	DEPTH
250.	20.
200.	150.
175.	250.
150.	400.
140.	500.
80.	750.
60.	1000.
50.	1500.
40.	2000.
30.	2500.
30.	3000.
20.	3500.
20.	4000.
20.	5000.

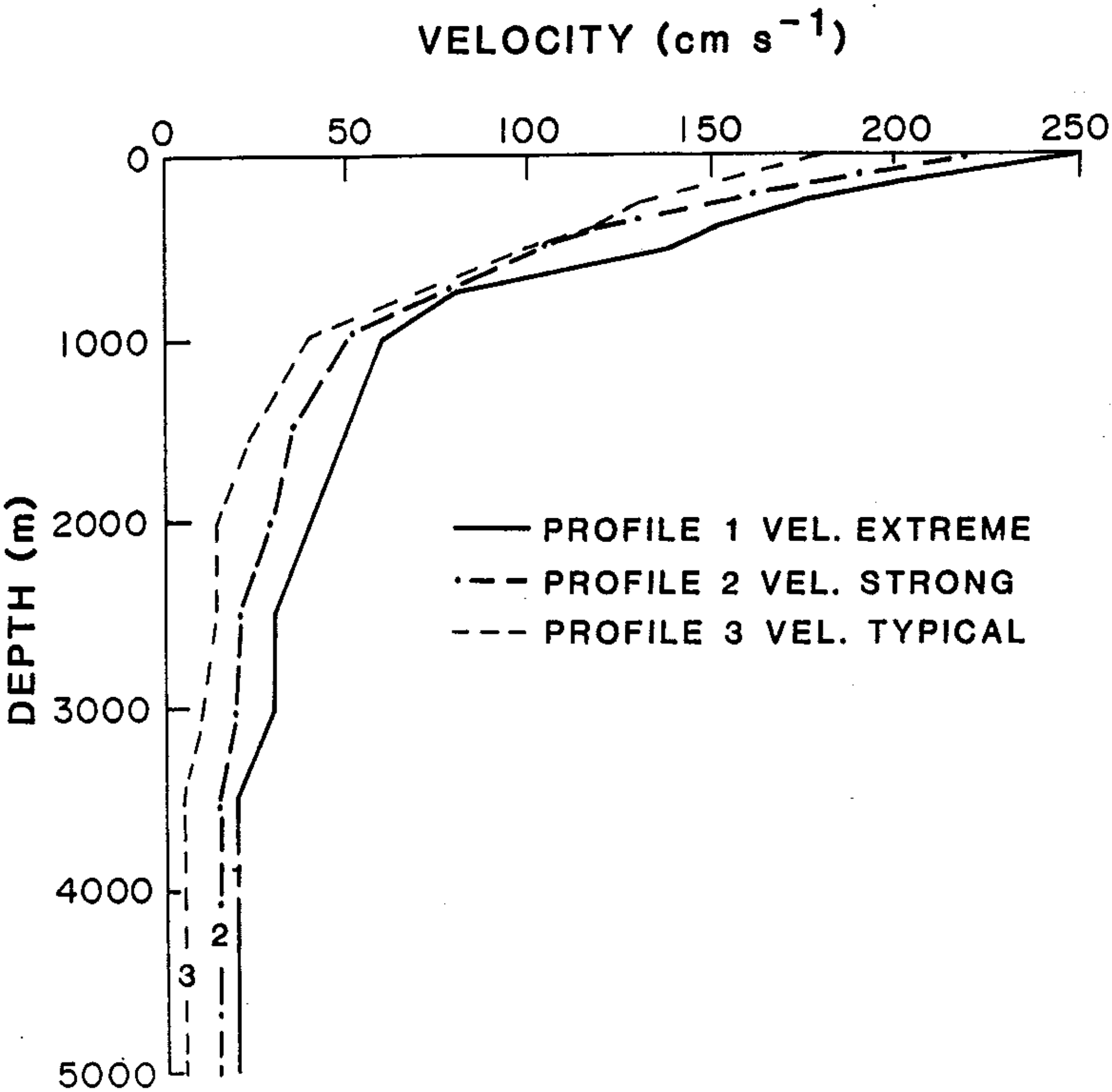
VELS.STRONG

VELOCITY	DEPTH
220.	20.
180.	150.
150.	250.
120.	400.
100.	500.
75.	750.
50.	1000.
35.	1500.
30.	2000.
20.	2500.
20.	3000.
15.	3500.
15.	4000.
15.	5000.

VELS.TYPICAL

VELOCITY	DEPTH
175.	20.
150.	150.
130.	250.
120.	400.
100.00	500.00
70.00	750.00
40.00	1000.00
25.	1500.
15.	2000.
15.	2500.
12.	3000.
5.	3500.
5.	4000.
5.	5000.

Figure 8 CURRENT VELOCITY PROFILES



APPENDIX D

The output file contains the mooring performance with a parachute, the launch performance with a parachute, the mooring performance without a parachute, and the launch performance without parachute.

For the outputs of the mooring performance, the following variable names are used:

1. NAME	Description of the segment.
2. DRAG	Horizontal drag (D) experienced by the segment in pounds.
3. SUMD	Sum of all the horizontal drag of all segments at and above the segment in pounds.
4. BMWT	Buoyancy-minus-weight of the segment in pounds.
5. SUMBMW	Sum of buoyancy-minus-weights of all segments at and above the segment in pounds.
6. THETA	Inclination of the segment in degrees.
7. DELH	The length of the segment minus the actual vertical distance spanned by the segment in meters (δh).
8. SUMDH	Sum of DELH (δh) of all segments below the segment in meters, i.e. the predicted displacement downward due to tilt below that segment.
9. DEPTH	Depth (in meters) of the segment in case of zero current and no elongation of lines.
10. SUMDELL	Sum of all the permanent and elastic elongations of all segments at and below the segment (in meters), i.e. the predicted upward displacement due to stretching.
11. TRUED	True depth (in meters) of the segment predicted by the program, i.e. TRUED = DEPTH-SUMDELL-SUMDH
12. TENSION	Tension (in pounds) in the segment at equilibrium position.
13. COST	Cost of the segment in dollars.
14. TOTAL	Total cost of all the segments at and above the segment in dollars.

For the outputs of the launch performance, the following variable names are used:

1.	NAME	Name of the segment.
2.	KD	Vertical drag factor of the segment.
3.	SUMKD	Sum of all the vertical drag factors of the segments at and below the segment in pounds/$(cm/s)^2$
4.	BMWT	Buoyancy-minus-weight (in pounds) of the segment.
5.	SUMBMW	Sum of buoyancy-minus-weights (in pounds) of all segments at and above the segment.
6.	VI	Maximum velocity (in cm/s) of the segment during launch. i.e. just as this segment gets drawn below the sea surface.
7.	TFINAL	Tension (in pounds) in the segment during launch after the terminal velocity has been reached. This is the maximum tension experienced during the launch (see section 3.1).

APPENDIX E

The following four tables describe mooring performance characteristics in three different current profiles and during the mooring launch.

1. Mooring performance in VELS.EXTREME profile

****
MOORING PERFORMANCE WITH PARACHUTE
****

1 NAME	DRAG	SUMD	BMWT	SUMBMW	THETA	DELH	SUMDH	DEPTH	SUMDELL	TRUED	TENSION	COST	TOTAL $$
ADCP-FISH	49.50	49.50	200.00	200.00	13.90	-0.01	-236.99	406.00	105.15	537.83	206.03	0.00	0.00
L1 (1/4 WIRE)	31.95	81.45	-2.85	197.15	22.45	-0.76	-236.97	406.50	105.15	538.31	213.31	20.00	20.00
SYN 60	183.38	264.82	1950.00	2147.15	7.03	-0.01	-236.22	416.50	105.14	547.56	2163.42	0.00	20.00
(3/16 WIRE)	7.69	272.52	-0.50	2146.65	7.23	-0.02	-236.20	418.00	105.14	549.05	2163.88	5.85	25.85
*(3/16 FAIR)	7.56	280.08	-1.22	2145.43	7.44	-0.06	-236.18	421.00	105.11	552.06	2163.63	13.65	39.50
AACM1	22.72	302.80	-40.00	2105.43	8.18	-0.01	-236.12	428.00	105.03	559.08	2127.09	0.00	39.50
L1 *(3/16 FAIR)	48.68	351.48	-8.09	2097.34	9.51	-0.64	-236.12	428.50	105.03	559.57	2126.59	90.67	130.17
L1 *(3/16 FAIR)	45.66	397.14	-8.09	2089.25	10.76	-0.82	-235.48	475.00	104.53	605.94	2126.66	90.67	220.85
L1 *(3/16 FAIR)	41.05	438.18	-8.09	2081.16	11.89	-1.00	-234.66	521.50	104.02	652.13	2126.79	90.67	311.52
L1 *(3/16 FAIR)	34.84	473.03	-8.09	2073.06	12.85	-1.17	-233.66	568.00	103.52	698.14	2126.35	90.67	402.20
(3/16 WIRE)	78.61	551.64	-9.69	2063.38	14.97	-1.97	-232.50	614.50	103.02	743.97	2135.85	113.10	515.30
(3/16 WIRE)	59.82	611.47	-9.69	2053.69	16.58	-2.41	-230.53	672.50	102.39	800.63	2142.79	113.10	628.40
AACM2	8.55	620.01	-40.00	2013.69	17.11	-0.02	-228.12	730.50	101.78	856.83	2106.98	0.00	628.40
L2 (3/16 WIRE)	43.36	663.38	-8.60	2005.09	18.31	-2.61	-228.09	731.00	101.78	857.31	2111.98	100.42	728.82
L2 (3/16 WIRE)	35.55	698.93	-8.60	1996.49	19.29	-2.89	-225.49	782.50	101.23	906.75	2115.30	100.42	829.25
L2 (3/16 WIRE)	31.89	730.82	-8.60	1987.89	20.18	-3.16	-222.60	834.00	100.70	955.89	2117.97	100.42	929.67
L2 (3/16 WIRE)	28.42	759.24	-8.60	1979.29	20.99	-3.42	-219.43	885.50	100.16	1004.77	2119.92	100.42	1030.10
L2 (3/16 WIRE)	25.16	784.40	-8.60	1970.69	21.70	-3.65	-216.02	937.00	99.63	1053.38	2121.06	100.42	1130.52
L2 (3/16 WIRE)	22.29	806.68	-8.60	1962.09	22.35	-3.87	-212.37	988.50	99.10	1101.76	2121.45	100.42	1230.95
AACM3	3.64	810.32	-40.00	1922.09	22.86	-0.04	-208.50	1040.00	98.57	1149.92	2085.92	0.00	1230.95
L3 (3/16 WIRE)	40.72	851.04	-17.15	1904.94	24.07	-8.93	-208.46	1040.50	98.57	1150.38	2086.40	200.26	1431.21
L3 (3/16 WIRE)	37.93	888.97	-17.15	1887.79	25.21	-9.79	-199.53	1143.20	97.54	1245.18	2086.63	200.26	1631.48
L3 (3/16 WIRE)	35.24	924.21	-17.15	1870.64	26.29	-10.62	-189.74	1245.90	96.51	1339.12	2086.49	200.26	1831.74
L3 (3/16 WIRE)	32.65	956.86	-17.15	1853.48	27.30	-11.44	-179.11	1348.60	95.50	1432.21	2085.90	200.26	2032.01
L3 (3/16 WIRE)	30.16	987.03	-17.15	1836.33	28.26	-12.24	-167.67	1451.30	94.50	1524.46	2084.79	200.26	2232.27
L3 (3/16 WIRE)	27.77	1014.80	-17.15	1819.18	29.15	-13.01	-155.43	1554.00	93.52	1615.91	2083.08	200.26	2432.54
L3 (3/16 WIRE)	25.48	1040.28	-17.15	1802.03	30.00	-13.76	-142.42	1656.70	92.54	1706.57	2080.74	200.26	2632.80
L3 (3/16 WIRE)	23.28	1063.56	-17.15	1784.88	30.79	-14.48	-128.66	1759.40	91.58	1796.48	2077.73	200.26	2833.07
L3 (3/16 WIRE)	21.19	1084.75	-17.15	1767.73	31.53	-15.17	-114.19	1862.10	90.63	1885.66	2074.02	200.26	3033.33
L3 (3/16 WIRE)	19.19	1103.94	-17.15	1750.58	32.23	-15.83	-99.02	1964.80	89.69	1974.13	2069.59	200.26	3233.60

GLASS SPHERE	76.80	1180.74	1680.00	3430.58	18.99	0.00	-83.19	2067.50	88.76	2061.93	3628.09	0.00	3233.60
CHAIN (3/8)	19.97	1200.71	-141.84	3288.74	20.06	-1.82	-83.19	2067.50	88.76	2061.93	3501.07	196.80	3430.40
AACM4	1.62	1202.32	-40.00	3248.74	20.31	-0.03	-81.37	2097.50	88.76	2090.11	3464.08	0.00	3430.40
L4 (9/16 DACRON)	34.74	1237.06	-8.32	3240.42	20.89	-6.21	-81.34	2098.00	88.76	2090.58	3468.52	135.13	3565.53
L4 (9/16 DACRON)	31.46	1268.52	-8.32	3232.10	21.43	-6.53	-75.13	2192.50	80.36	2187.26	3472.12	135.13	3700.67
L4 (9/16 DACRON)	28.34	1296.85	-8.32	3223.79	21.91	-6.83	-68.59	2287.00	71.99	2283.60	3474.86	135.13	3835.80
L4 (9/16 DACRON)	25.38	1322.24	-8.32	3215.47	22.35	-7.10	-61.77	2381.50	63.64	2379.63	3476.72	135.13	3970.94
L4 (9/16 DACRON)	22.59	1344.83	-8.32	3207.16	22.75	-7.35	-54.67	2476.00	55.30	2475.36	3477.70	135.13	4106.07
L4 (9/16 DACRON)	20.87	1365.70	-8.32	3198.84	23.12	-7.59	-47.31	2570.50	46.99	2570.82	3478.18	135.13	4241.21
L4 (9/16 DACRON)	20.50	1386.20	-8.32	3190.52	23.48	-7.83	-39.72	2665.00	38.70	2666.02	3478.65	135.13	4376.34
L4 (9/16 DACRON)	20.50	1406.70	-8.32	3182.21	23.85	-8.07	-31.90	2759.50	30.42	2760.97	3479.26	135.13	4511.47
L4 (9/16 DACRON)	20.50	1427.19	-8.32	3173.89	24.21	-8.31	-23.83	2854.00	22.17	2855.66	3480.01	135.13	4646.61
L4 (9/16 DACRON)	20.50	1447.69	-8.32	3165.57	24.57	-8.56	-15.52	2948.50	13.93	2950.08	3480.90	135.13	4781.74
GLASS SPHERE	4.32	1452.01	168.00	3333.57	23.54	0.00	-6.96	3043.00	5.72	3044.24	3636.08	0.00	4781.74
CHAIN (3/8)	1.12	1453.13	-14.18	3319.39	23.64	-0.25	-6.96	3043.00	5.72	3044.24	3623.53	19.68	4801.42
(3/8 WIRE)	4.22	1457.35	-13.79	3305.60	23.79	-1.87	-6.70	3046.00	5.72	3046.99	3612.59	171.60	4973.02
SEDIMENT TRAP	9.94	1467.29	-110.00	3195.60	24.66	0.00	-4.83	3068.00	5.60	3067.24	3516.36	0.00	4973.02
GLASS SPHERE	12.96	1480.25	504.00	3699.60	21.81	0.00	-4.83	3068.00	5.60	3067.24	3984.74	0.00	4973.02
CHAIN (3/8)	3.37	1483.62	-42.55	3657.04	22.08	-0.66	-4.83	3068.00	5.60	3067.24	3946.53	59.04	5032.06
AACM5	0.91	1484.53	-40.00	3617.04	22.31	-0.04	-4.17	3077.00	5.60	3075.58	3909.84	0.00	5032.06
DOUBLE RELEASE	7.06	1491.59	-140.00	3477.04	23.22	-0.16	-4.14	3077.50	5.60	3076.04	3783.47	2000.00	7032.06
NYLON (3/4)	14.06	1505.65	-1.55	3475.49	23.42	-2.06	-3.97	3079.50	5.60	3077.88	3787.62	63.50	7095.56
CHAIN (1/2)	9.99	1515.64	-161.62	3313.87	24.58	-1.81	-1.91	3104.50	0.00	3106.41	3644.02	157.40	7252.96
ANCHOR MACE	0.00	1515.64	-5300.00	-1986.13	-37.35	-0.10	-0.10	3124.50	0.00	3124.60	2498.37	1974.00	9226.96
PARACHUTE 7FT	0.00	1515.64	0.00	-1986.13	0.00	0.00	0.00	3125.00	0.00	3125.00	2498.37	100.00	9326.96

****
WARNING
****

ELEMENT 44 HAS INADEQUATE BOUYANCY TO LIFT EVERYTHING IF ADJACENT FLOATATION BROKE OFF.

RSUM= -402.98
BMWT= 168.00
28

****

MOORING PERFORMANCE WITHOUT PARACHUTE

****

1 NAME	DRAG	SUMD	BMWT	SUMBMW	THETA	DELH	SUMDH	DEPTH	SUMDELL	TRUED	TENSION	COST	TOTAL $$
ADCP-FISH	49.50	49.50	200.00	200.00	13.90	-0.01	-236.99	406.00	108.54	534.44	206.03	0.00	0.00
L1 (1/4 WIRE)	31.95	81.45	-2.85	197.15	22.45	-0.76	-236.97	406.50	108.54	534.92	213.31	20.00	20.00
SYN 60	183.38	264.82	1950.00	2147.15	7.03	-0.01	-236.22	416.50	108.53	544.17	2163.42	0.00	20.00
(3/16 WIRE)	7.69	272.52	-0.50	2146.65	7.23	-0.02	-236.20	418.00	108.53	545.66	2163.88	5.85	25.85
*(3/16 FAIR)	7.56	280.08	-1.22	2145.43	7.44	-0.06	-236.18	421.00	108.50	548.67	2163.63	13.65	39.50
AACM1	22.72	302.80	-40.00	2105.43	8.18	-0.01	-236.12	428.00	108.42	555.69	2127.09	0.00	39.50
L1 *(3/16 FAIR)	48.68	351.48	-8.09	2097.34	9.51	-0.64	-236.12	428.50	108.42	556.19	2126.59	90.67	130.17
L1 *(3/16 FAIR)	45.66	397.14	-8.09	2089.25	10.76	-0.82	-235.48	475.00	107.91	602.56	2126.66	90.67	220.85
L1 *(3/16 FAIR)	41.05	438.18	-8.09	2081.16	11.89	-1.00	-234.66	521.50	107.40	648.76	2126.79	90.67	311.52
L1 *(3/16 FAIR)	34.84	473.03	-8.09	2073.06	12.85	-1.17	-233.66	568.00	106.88	694.77	2126.35	90.67	402.20
(3/16 WIRE)	78.61	551.64	-9.69	2063.38	14.97	-1.97	-232.50	614.50	106.37	740.61	2135.85	113.10	515.30
(3/16 WIRE)	59.82	611.47	-9.69	2053.69	16.58	-2.41	-230.53	672.50	105.74	797.28	2142.79	113.10	628.40
AACM2	8.55	620.01	-40.00	2013.69	17.11	-0.02	-228.12	730.50	105.12	853.49	2106.98	0.00	628.40
L2 (3/16 WIRE)	43.36	663.38	-8.60	2005.09	18.31	-2.61	-228.09	731.00	105.12	853.97	2111.98	100.42	728.82
L2 (3/16 WIRE)	35.55	698.93	-8.60	1996.49	19.29	-2.89	-225.49	782.50	104.56	903.42	2115.30	100.42	829.25
L2 (3/16 WIRE)	31.89	730.82	-8.60	1987.89	20.18	-3.16	-222.60	834.00	104.01	952.58	2117.97	100.42	929.67
L2 (3/16 WIRE)	28.42	759.24	-8.60	1979.29	20.99	-3.42	-219.43	885.50	103.46	1001.46	2119.92	100.42	1030.10
L2 (3/16 WIRE)	25.16	784.40	-8.60	1970.69	21.70	-3.65	-216.02	937.00	102.92	1050.09	2121.06	100.42	1130.52
L2 (3/16 WIRE)	22.29	806.68	-8.60	1962.09	22.35	-3.87	-212.37	988.50	102.38	1098.48	2121.45	100.42	1230.95
AACM3	3.64	810.32	-40.00	1922.09	22.86	-0.04	-208.50	1040.00	101.84	1146.65	2085.92	0.00	1230.95
L3 (3/16 WIRE)	40.72	851.04	-17.15	1904.94	24.07	-8.93	-208.46	1040.50	101.84	1147.11	2086.40	200.26	1431.21
L3 (3/16 WIRE)	37.93	888.97	-17.15	1887.79	25.21	-9.79	-199.53	1143.20	100.77	1241.95	2086.63	200.26	1631.48
L3 (3/16 WIRE)	35.24	924.21	-17.15	1870.64	26.29	-10.62	-189.74	1245.90	99.72	1335.92	2086.49	200.26	1831.74
L3 (3/16 WIRE)	32.65	956.86	-17.15	1853.48	27.30	-11.44	-179.11	1348.60	98.68	1429.03	2085.90	200.26	2032.01
L3 (3/16 WIRE)	30.16	987.03	-17.15	1836.33	28.26	-12.24	-167.67	1451.30	97.65	1521.32	2084.79	200.26	2232.27
L3 (3/16 WIRE)	27.77	1014.80	-17.15	1819.18	29.15	-13.01	-155.43	1554.00	96.63	1612.80	2083.08	200.26	2432.54
L3 (3/16 WIRE)	25.48	1040.28	-17.15	1802.03	30.00	-13.76	-142.42	1656.70	95.62	1703.49	2080.74	200.26	2632.80
L3 (3/16 WIRE)	23.28	1063.56	-17.15	1784.88	30.79	-14.48	-128.66	1759.40	94.63	1793.43	2077.73	200.26	2833.07
L3 (3/16 WIRE)	21.19	1084.75	-17.15	1767.73	31.53	-15.17	-114.19	1862.10	93.64	1882.64	2074.02	200.26	3033.33
L3 (3/16 WIRE)	19.19	1103.94	-17.15	1750.58	32.23	-15.83	-99.02	1964.80	92.67	1971.15	2069.59	200.26	3233.60
GLASS SPHERE	76.80	1180.74	1680.00	3430.58	18.99	0.00	-83.19	2067.50	91.71	2058.98	3628.09	0.00	3233.60
CHAIN (3/8)	19.97	1200.71	-141.84	3288.74	20.06	-1.82	-83.19	2067.50	91.71	2058.98	3501.07	196.80	3430.40
AACM4	1.62	1202.32	-40.00	3248.74	20.31	-0.03	-81.37	2097.50	91.71	2087.16	3464.08	0.00	3430.40

L4 (9/16 DACRON)	34.74	1237.06	-8.32	3240.42	20.89	-6.21	-81.34	2098.00	91.71	2087.63	3468.52	135.13	3565.53
L4 (9/16 DACRON)	31.46	1268.52	-8.32	3232.10	21.43	-6.53	-75.13	2192.50	83.05	2184.57	3472.12	135.13	3700.67
L4 (9/16 DACRON)	28.34	1296.85	-8.32	3223.79	21.91	-6.83	-68.59	2287.00	74.41	2281.18	3474.86	135.13	3835.80
L4 (9/16 DACRON)	25.38	1322.24	-8.32	3215.47	22.35	-7.10	-61.77	2381.50	65.79	2377.47	3476.72	135.13	3970.94
L4 (9/16 DACRON)	22.59	1344.83	-8.32	3207.16	22.75	-7.35	-54.67	2476.00	57.19	2473.47	3477.70	135.13	4106.07
L4 (9/16 DACRON)	20.87	1365.70	-8.32	3198.84	23.12	-7.59	-47.31	2570.50	48.60	2569.21	3478.18	135.13	4241.21
L4 (9/16 DACRON)	20.50	1386.20	-8.32	3190.52	23.48	-7.83	-39.72	2665.00	40.03	2664.69	3478.65	135.13	4376.34
L4 (9/16 DACRON)	20.50	1406.70	-8.32	3182.21	23.85	-8.07	-31.90	2759.50	31.48	2759.91	3479.26	135.13	4511.47
L4 (9/16 DACRON)	20.50	1427.19	-8.32	3173.89	24.21	-8.31	-23.83	2854.00	22.95	2854.88	3480.01	135.13	4646.61
L4 (9/16 DACRON)	20.50	1447.69	-8.32	3165.57	24.57	-8.56	-15.52	2948.50	14.43	2949.58	3480.90	135.13	4781.74
GLASS SPHERE	4.32	1452.01	168.00	3333.57	23.54	0.00	-6.96	3043.00	5.93	3044.02	3636.08	0.00	4781.74
CHAIN (3/8)	1.12	1453.13	-14.18	3319.39	23.64	-0.25	-6.96	3043.00	5.93	3044.02	3623.53	19.68	4801.42
(3/8 WIRE)	4.22	1457.35	-13.79	3305.60	23.79	-1.87	-6.70	3046.00	5.93	3046.77	3612.59	171.60	4973.02
SEDIMENT TRAP	9.94	1467.29	-110.00	3195.60	24.66	0.00	-4.83	3068.00	5.80	3067.03	3516.36	0.00	4973.02
GLASS SPHERE	12.96	1480.25	504.00	3699.60	21.81	0.00	-4.83	3068.00	5.80	3067.03	3984.74	0.00	4973.02
CHAIN (3/8)	3.37	1483.62	-42.55	3657.04	22.08	-0.66	-4.83	3068.00	5.80	3067.03	3946.53	59.04	5032.06
AACM5	0.91	1484.53	-40.00	3617.04	22.31	-0.04	-4.17	3077.00	5.80	3075.37	3909.84	0.00	5032.06
DOUBLE RELEASE	7.06	1491.59	-140.00	3477.04	23.22	-0.16	-4.14	3077.50	5.80	3075.83	3783.47	2000.00	7032.06
NYLON (3/4)	14.06	1505.65	-1.55	3475.49	23.42	-2.06	-3.97	3079.50	5.80	3077.67	3787.62	63.50	7095.56
CHAIN (1/2)	9.99	1515.64	-161.62	3313.87	24.58	-1.81	-1.91	3104.50	0.00	3106.41	3644.02	157.40	7252.96
ANCHOR MACE	0.00	1515.64	-5300.00	-1986.13	-37.35	-0.10	-0.10	3124.50	0.00	3124.60	2498.37	1974.00	9226.96

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WARNING

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ELEMENT 44 HAS INADEQUATE BOUYANCY TO LIFT EVERYTHING IF ADJACENT FLOATATION BROKE OFF.

RSUM= -402.98
BMWT= 168.00
28

2. Mooring Performance in VELS.STRONG profile

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MOORING PERFORMANCE WITH PARACHUTE
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1 NAME	DRAG	SUMD	BMWT	SUMBMW	THETA	DELH	SUMDH	DEPTH	SUMDELL	TRUED	TENSION	COST	TOTAL $$
ADCP-FISH	31.68	31.68	200.00	200.00	9.00	-0.01	-107.02	406.00	107.88	405.14	202.49	0.00	0.00
L1 (1/4 WIRE)	20.45	52.13	-2.85	197.15	14.81	-0.33	-107.02	406.50	107.88	405.64	203.93	20.00	20.00
SYN 60	117.36	169.49	1950.00	2147.15	4.51	-0.00	-106.69	416.50	107.87	415.31	2153.83	0.00	20.00
(3/16 WIRE)	4.92	174.41	-0.50	2146.65	4.64	-0.01	-106.68	418.00	107.87	416.81	2153.72	5.85	25.85
*(3/16 FAIR)	4.84	179.25	-1.22	2145.43	4.78	-0.02	-106.67	421.00	107.84	419.83	2152.91	13.65	39.50
AACM1	14.54	193.80	-40.00	2105.43	5.26	-0.00	-106.65	428.00	107.76	426.88	2114.33	0.00	39.50
L1 *(3/16 FAIR)	29.70	223.49	-8.09	2097.34	6.08	-0.26	-106.64	428.50	107.76	427.38	2109.21	90.67	130.17
L1 *(3/16 FAIR)	25.10	248.60	-8.09	2089.25	6.79	-0.33	-106.38	475.00	107.25	474.13	2103.99	90.67	220.85
L1 *(3/16 FAIR)	21.75	270.35	-8.09	2081.16	7.40	-0.39	-106.06	521.50	106.74	520.81	2098.64	90.67	311.52
L1 *(3/16 FAIR)	19.61	289.96	-8.09	2073.06	7.96	-0.45	-105.67	568.00	106.23	567.43	2093.24	90.67	402.20
(3/16 WIRE)	50.16	340.12	-9.69	2063.38	9.36	-0.77	-105.22	614.50	105.72	613.99	2091.22	113.10	515.30
(3/16 WIRE)	43.70	383.82	-9.69	2053.69	10.59	-0.99	-104.45	672.50	105.09	671.85	2089.25	113.10	628.40
AACM2	6.46	390.29	-40.00	2013.69	10.97	-0.01	-103.46	730.50	104.47	729.49	2051.17	0.00	628.40
L2 (3/16 WIRE)	35.19	425.48	-8.60	2005.09	11.98	-1.12	-103.45	731.00	104.47	729.98	2049.74	100.42	728.82
L2 (3/16 WIRE)	30.67	456.15	-8.60	1996.49	12.87	-1.29	-102.33	782.50	103.91	780.91	2047.94	100.42	829.25
L2 (3/16 WIRE)	26.45	482.60	-8.60	1987.89	13.64	-1.45	-101.04	834.00	103.36	831.67	2045.63	100.42	929.67
L2 (3/16 WIRE)	22.55	505.15	-8.60	1979.29	14.32	-1.60	-99.58	885.50	102.81	882.26	2042.74	100.42	1030.10
L2 (3/16 WIRE)	18.96	524.11	-8.60	1970.69	14.89	-1.73	-97.98	937.00	102.27	932.71	2039.19	100.42	1130.52
L2 (3/16 WIRE)	15.87	539.98	-8.60	1962.09	15.39	-1.85	-96.25	988.50	101.72	983.02	2035.04	100.42	1230.95
AACM3	2.52	542.50	-40.00	1922.09	15.76	-0.02	-94.41	1040.00	101.18	1033.22	1997.18	0.00	1230.95
L3 (3/16 WIRE)	27.49	570.00	-17.15	1904.94	16.66	-4.31	-94.39	1040.50	101.18	1033.70	1988.39	200.26	1431.21
L3 (3/16 WIRE)	24.11	594.11	-17.15	1887.79	17.47	-4.74	-90.08	1143.20	100.11	1133.16	1979.07	200.26	1631.48
L3 (3/16 WIRE)	20.95	615.05	-17.15	1870.64	18.20	-5.14	-85.34	1245.90	99.05	1232.18	1969.15	200.26	1831.74
L3 (3/16 WIRE)	18.01	633.06	-17.15	1853.48	18.86	-5.51	-80.20	1348.60	98.00	1330.80	1958.61	200.26	2032.01
L3 (3/16 WIRE)	15.40	648.46	-17.15	1836.33	19.45	-5.86	-74.69	1451.30	96.96	1429.03	1947.47	200.26	2232.27
L3 (3/16 WIRE)	13.82	662.27	-17.15	1819.18	20.00	-6.20	-68.83	1554.00	95.93	1526.90	1935.98	200.26	2432.54
L3 (3/16 WIRE)	13.00	675.28	-17.15	1802.03	20.54	-6.53	-62.64	1656.70	94.90	1624.43	1924.40	200.26	2632.80
L3 (3/16 WIRE)	12.21	687.49	-17.15	1784.88	21.06	-6.86	-56.10	1759.40	93.89	1721.61	1912.70	200.26	2833.07
L3 (3/16 WIRE)	11.45	698.94	-17.15	1767.73	21.57	-7.19	-49.24	1862.10	92.88	1818.45	1900.89	200.26	3033.33
L3 (3/16 WIRE)	10.61	709.55	-17.15	1750.58	22.06	-7.52	-42.05	1964.80	91.89	1914.96	1888.91	200.26	3233.60
GLASS SPHERE	43.20	752.75	1680.00	3430.58	12.38	0.00	-34.53	2067.50	90.90	2011.12	3512.19	0.00	3233.60

CHAIN (3/8)	11.23	763.98	-141.84	3288.74	13.08	-0.78	-34.53	2067.50	90.90	2011.12	3376.31	196.80	3430.40
AACM4	0.91	764.89	-40.00	3248.74	13.25	-0.01	-33.75	2097.50	90.90	2040.35	3337.57	0.00	3430.40
L4 (9/16 DACRON)	19.23	784.12	-8.32	3240.42	13.60	-2.65	-33.73	2098.00	90.90	2040.83	3333.94	135.13	3565.53
L4 (9/16 DACRON)	16.81	800.92	-8.32	3232.10	13.92	-2.77	-31.08	2192.50	82.34	2141.24	3329.86	135.13	3700.67
L4 (9/16 DACRON)	14.55	815.47	-8.32	3223.79	14.19	-2.89	-28.31	2287.00	73.79	2241.51	3325.33	135.13	3835.80
L4 (9/16 DACRON)	12.45	827.93	-8.32	3215.47	14.44	-2.98	-25.42	2381.50	65.26	2341.66	3320.35	135.13	3970.94
L4 (9/16 DACRON)	10.52	838.45	-8.32	3207.16	14.65	-3.07	-22.44	2476.00	56.74	2441.69	3314.94	135.13	4106.07
L4 (9/16 DACRON)	9.36	847.81	-8.32	3198.84	14.84	-3.15	-19.37	2570.50	48.23	2541.63	3309.28	135.13	4241.21
L4 (9/16 DACRON)	9.11	856.92	-8.32	3190.52	15.03	-3.23	-16.21	2665.00	39.74	2641.47	3303.60	135.13	4376.34
L4 (9/16 DACRON)	9.11	866.03	-8.32	3182.21	15.22	-3.32	-12.98	2759.50	31.25	2741.23	3297.95	135.13	4511.47
L4 (9/16 DACRON)	9.11	875.14	-8.32	3173.89	15.41	-3.40	-9.66	2854.00	22.78	2840.88	3292.33	135.13	4646.61
L4 (9/16 DACRON)	9.11	884.25	-8.32	3165.57	15.61	-3.48	-6.26	2948.50	14.31	2940.45	3286.75	135.13	4781.74
GLASS SPHERE	1.92	886.17	168.00	3333.57	14.89	0.00	-2.78	3043.00	5.86	3039.91	3449.35	0.00	4781.74
CHAIN (3/8)	0.50	886.67	-14.18	3319.39	14.95	-0.10	-2.78	3043.00	5.86	3039.91	3435.77	19.68	4801.42
(3/8 WIRE)	1.87	888.54	-13.79	3305.60	15.04	-0.75	-2.68	3046.00	5.86	3042.81	3422.93	171.60	4973.02
SEDIMENT TRAP	4.42	892.96	-110.00	3195.60	15.61	0.00	-1.92	3068.00	5.74	3064.18	3318.01	0.00	4973.02
GLASS SPHERE	5.76	898.72	504.00	3699.60	13.65	0.00	-1.92	3068.00	5.74	3064.18	3807.19	0.00	4973.02
CHAIN (3/8)	1.50	900.22	-42.55	3657.04	13.83	-0.26	-1.92	3068.00	5.74	3064.18	3766.21	59.04	5032.06
AACM5	0.40	900.62	-40.00	3617.04	13.98	-0.01	-1.66	3077.00	5.74	3072.92	3727.48	0.00	5032.06
DOUBLE RELEASE	3.14	903.76	-140.00	3477.04	14.57	-0.06	-1.65	3077.50	5.74	3073.41	3592.58	2000.00	7032.06
NYLON (3/4)	6.25	910.01	-1.55	3475.49	14.67	-0.82	-1.58	3079.50	5.74	3075.34	3592.65	63.50	7095.56
CHAIN (1/2)	4.44	914.45	-161.62	3313.87	15.43	-0.72	-0.77	3104.50	0.00	3105.27	3437.73	157.40	7252.96
ANCHOR MACE	0.00	914.45	-5300.00	-1986.13	-24.72	-0.05	-0.05	3124.50	0.00	3124.55	2186.53	1974.00	9226.96
PARACHUTE 7FT	0.00	914.45	0.00	-1986.13	0.00	0.00	0.00	3125.00	0.00	3125.00	2186.53	100.00	9326.96

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WARNING
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ELEMENT 44 HAS INADEQUATE BOUYANCY TO LIFT EVERYTHING IF ADJACENT FLOATATION BROKE OFF.

RSUM= -402.98
BMWT= 168.00
28

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MOORING PERFORMANCE WITHOUT PARACHUTE

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1 NAME	DRAG	SUMD	BMWT	SUMBMW	THETA	DELH	SUMDH	DEPTH	SUMDELL	TRUED	TENSION	COST	TOTAL $:
ADCP-FISH	31.68	31.68	200.00	200.00	9.00	-0.01	-107.02	406.00	111.44	401.58	202.49	0.00	0.00
L1 (1/4 WIRE)	20.45	52.13	-2.85	197.15	14.81	-0.33	-107.02	406.50	111.44	402.07	203.93	20.00	20.00
SYN 60	117.36	169.49	1950.00	2147.15	4.51	-0.00	-106.69	416.50	111.43	411.74	2153.83	0.00	20.00
(3/16 WIRE)	4.92	174.41	-0.50	2146.65	4.64	-0.01	-106.68	418.00	111.43	413.24	2153.72	5.85	25.85
*(3/16 FAIR)	4.84	179.25	-1.22	2145.43	4.78	-0.02	-106.67	421.00	111.40	416.26	2152.91	13.65	39.50
AACM1	14.54	193.80	-40.00	2105.43	5.26	-0.00	-106.65	428.00	111.32	423.32	2114.33	0.00	39.50
L1 *(3/16 FAIR)	29.70	223.49	-8.09	2097.34	6.08	-0.26	-106.64	428.50	111.32	423.81	2109.21	90.67	130.17
L1 *(3/16 FAIR)	25.10	248.60	-8.09	2089.25	6.79	-0.33	-106.38	475.00	110.81	470.57	2103.99	90.67	220.85
L1 *(3/16 FAIR)	21.75	270.35	-8.09	2081.16	7.40	-0.39	-106.06	521.50	110.29	517.26	2098.64	90.67	311.52
L1 *(3/16 FAIR)	19.61	289.96	-8.09	2073.06	7.96	-0.45	-105.67	568.00	109.77	563.89	2093.24	90.67	402.20
(3/16 WIRE)	50.16	340.12	-9.69	2063.38	9.36	-0.77	-105.22	614.50	109.26	610.46	2091.22	113.10	515.30
(3/16 WIRE)	43.70	383.82	-9.69	2053.69	10.59	-0.99	-104.45	672.50	108.62	668.33	2089.25	113.10	628.40
AACM2	6.46	390.29	-40.00	2013.69	10.97	-0.01	-103.46	730.50	107.98	725.98	2051.17	0.00	628.40
L2 (3/16 WIRE)	35.19	425.48	-8.60	2005.09	11.98	-1.12	-103.45	731.00	107.98	726.47	2049.74	100.42	728.82
L2 (3/16 WIRE)	30.67	456.15	-8.60	1996.49	12.87	-1.29	-102.33	782.50	107.41	777.41	2047.94	100.42	829.25
L2 (3/16 WIRE)	26.45	482.60	-8.60	1987.89	13.64	-1.45	-101.04	834.00	106.85	828.18	2045.63	100.42	929.67
L2 (3/16 WIRE)	22.55	505.15	-8.60	1979.29	14.32	-1.60	-99.58	885.50	106.29	878.79	2042.74	100.42	1030.10
L2 (3/16 WIRE)	18.96	524.11	-8.60	1970.69	14.89	-1.73	-97.98	937.00	105.73	929.25	2039.19	100.42	1130.52
L2 (3/16 WIRE)	15.87	539.98	-8.60	1962.09	15.39	-1.85	-96.25	988.50	105.17	979.57	2035.04	100.42	1230.95
AACM3	2.52	542.50	-40.00	1922.09	15.76	-0.02	-94.41	1040.00	104.62	1029.78	1997.18	0.00	1230.95
L3 (3/16 WIRE)	27.49	570.00	-17.15	1904.94	16.66	-4.31	-94.39	1040.50	104.62	1030.26	1988.39	200.26	1431.21
L3 (3/16 WIRE)	24.11	594.11	-17.15	1887.79	17.47	-4.74	-90.08	1143.20	103.52	1129.75	1979.07	200.26	1631.48
L3 (3/16 WIRE)	20.95	615.05	-17.15	1870.64	18.20	-5.14	-85.34	1245.90	102.43	1228.81	1969.15	200.26	1831.74
L3 (3/16 WIRE)	18.01	633.06	-17.15	1853.48	18.86	-5.51	-80.20	1348.60	101.34	1327.46	1958.61	200.26	2032.01
L3 (3/16 WIRE)	15.40	648.46	-17.15	1836.33	19.45	-5.86	-74.69	1451.30	100.27	1425.72	1947.47	200.26	2232.27
L3 (3/16 WIRE)	13.82	662.27	-17.15	1819.18	20.00	-6.20	-68.83	1554.00	99.20	1523.62	1935.98	200.26	2432.54
L3 (3/16 WIRE)	13.00	675.28	-17.15	1802.03	20.54	-6.53	-62.64	1656.70	98.14	1621.19	1924.40	200.26	2632.80
L3 (3/16 WIRE)	12.21	687.49	-17.15	1784.88	21.06	-6.86	-56.10	1759.40	97.09	1718.41	1912.70	200.26	2833.07
L3 (3/16 WIRE)	11.45	698.94	-17.15	1767.73	21.57	-7.19	-49.24	1862.10	96.05	1815.28	1900.89	200.26	3033.33
L3 (3/16 WIRE)	10.61	709.55	-17.15	1750.58	22.06	-7.52	-42.05	1964.80	95.02	1911.82	1888.91	200.26	3233.60
GLASS SPHERE	43.20	752.75	1680.00	3430.58	12.38	0.00	-34.53	2067.50	94.00	2008.02	3512.19	0.00	3233.60
CHAIN (3/8)	11.23	763.98	-141.84	3288.74	13.08	-0.78	-34.53	2067.50	94.00	2008.02	3376.31	196.80	3430.40
AACM4	0.91	764.89	-40.00	3248.74	13.25	-0.01	-33.75	2097.50	94.00	2037.25	3337.57	0.00	3430.40

L4 (9/16 DACRON)	19.23	784.12	-8.32	3240.42	13.60	-2.65	-33.73	2098.00	94.00	2037.73	3333.94	135.13	3565.53
L4 (9/16 DACRON)	16.81	800.92	-8.32	3232.10	13.92	-2.77	-31.08	2192.50	85.16	2138.42	3329.86	135.13	3700.67
L4 (9/16 DACRON)	14.55	815.47	-8.32	3223.79	14.19	-2.89	-28.31	2287.00	76.34	2238.96	3325.33	135.13	3835.80
L4 (9/16 DACRON)	12.45	827.93	-8.32	3215.47	14.44	-2.98	-25.42	2381.50	67.53	2339.39	3320.35	135.13	3970.94
L4 (9/16 DACRON)	10.52	838.45	-8.32	3207.16	14.65	-3.07	-22.44	2476.00	58.73	2439.71	3314.94	135.13	4106.07
L4 (9/16 DACRON)	9.36	847.81	-8.32	3198.84	14.84	-3.15	-19.37	2570.50	49.93	2539.93	3309.28	135.13	4241.21
L4 (9/16 DACRON)	9.11	856.92	-8.32	3190.52	15.03	-3.23	-16.21	2665.00	41.15	2640.06	3303.60	135.13	4376.34
L4 (9/16 DACRON)	9.11	866.03	-8.32	3182.21	15.22	-3.32	-12.98	2759.50	32.37	2740.11	3297.95	135.13	4511.47
L4 (9/16 DACRON)	9.11	875.14	-8.32	3173.89	15.41	-3.40	-9.66	2854.00	23.60	2840.06	3292.33	135.13	4646.61
L4 (9/16 DACRON)	9.11	884.25	-8.32	3165.57	15.61	-3.48	-6.26	2948.50	14.84	2939.92	3286.75	135.13	4781.74
GLASS SPHERE	1.92	886.17	168.00	3333.57	14.89	0.00	-2.78	3043.00	6.09	3039.69	3449.35	0.00	4781.74
CHAIN (3/8)	0.50	886.67	-14.18	3319.39	14.95	-0.10	-2.78	3043.00	6.09	3039.69	3435.77	19.68	4801.42
(3/8 WIRE)	1.87	888.54	-13.79	3305.60	15.04	-0.75	-2.68	3046.00	6.09	3042.59	3422.93	171.60	4973.02
SEDIMENT TRAP	4.42	892.96	-110.00	3195.60	15.61	0.00	-1.92	3068.00	5.95	3063.97	3318.01	0.00	4973.02
GLASS SPHERE	5.76	898.72	504.00	3699.60	13.65	0.00	-1.92	3068.00	5.95	3063.97	3807.19	0.00	4973.02
CHAIN (3/8)	1.50	900.22	-42.55	3657.04	13.83	-0.26	-1.92	3068.00	5.95	3063.97	3766.21	59.04	5032.06
AACM5	0.40	900.62	-40.00	3617.04	13.98	-0.01	-1.66	3077.00	5.95	3072.70	3727.48	0.00	5032.06
DOUBLE RELEASE	3.14	903.76	-140.00	3477.04	14.57	-0.06	-1.65	3077.50	5.95	3073.19	3592.58	2000.00	7032.06
NYLON (3/4)	6.25	910.01	-1.55	3475.49	14.67	-0.82	-1.58	3079.50	5.95	3075.13	3592.65	63.50	7095.56
CHAIN (1/2)	4.44	914.45	-161.62	3313.87	15.43	-0.72	-0.77	3104.50	0.00	3105.27	3437.73	157.40	7252.96
ANCHOR MACE	0.00	914.45	-5300.00	-1986.13	-24.72	-0.05	-0.05	3124.50	0.00	3124.55	2186.53	1974.00	9226.96

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WARNING
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ELEMENT 44 HAS INADEQUATE BOUYANCY TO LIFT EVERYTHING IF ADJACENT FLOATATION BROKE OFF.

RSUM= -402.98
BMWT= 168.00
28

3. Mooring performance in VELS.TYPICAL profile

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      MOORING PERFORMANCE WITH PARACHUTE
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1 NAME	DRAG	SUMD	BMWT	SUMBMW	THETA	DELH	SUMDH	DEPTH	SUMDELL	TRUED	TENSION	COST	TOTAL $
ADCP-FISH	31.68	31.68	200.00	200.00	9.00	-0.01	-77.49	406.00	108.63	374.85	202.49	0.00	0.00
L1 (1/4 WIRE)	20.45	52.13	-2.85	197.15	14.81	-0.33	-77.48	406.50	108.63	375.35	203.93	20.00	20.00
SYN 60	117.36	169.49	1950.00	2147.15	4.51	-0.00	-77.15	416.50	108.62	385.02	2153.83	0.00	20.00
(3/16 WIRE)	4.92	174.41	-0.50	2146.65	4.64	-0.01	-77.14	418.00	108.62	386.52	2153.72	5.85	25.85
*(3/16 FAIR)	4.84	179.25	-1.22	2145.43	4.78	-0.02	-77.13	421.00	108.59	389.54	2152.91	13.65	39.50
AACM1	14.54	193.80	-40.00	2105.43	5.26	-0.00	-77.11	428.00	108.51	396.59	2114.33	0.00	39.50
L1 *(3/16 FAIR)	29.70	223.49	-8.09	2097.34	6.08	-0.26	-77.11	428.50	108.51	397.09	2109.21	90.67	130.17
L1 *(3/16 FAIR)	25.10	248.60	-8.09	2089.25	6.79	-0.33	-76.85	475.00	108.00	443.84	2103.99	90.67	220.85
L1 *(3/16 FAIR)	21.58	270.18	-8.09	2081.16	7.40	-0.39	-76.52	521.50	107.49	490.52	2098.62	90.67	311.52
L1 *(3/16 FAIR)	19.09	289.26	-8.09	2073.06	7.94	-0.45	-76.13	568.00	106.98	537.14	2093.15	90.67	402.20
(3/16 WIRE)	47.23	336.50	-9.69	2063.38	9.26	-0.76	-75.69	614.50	106.48	583.70	2090.64	113.10	515.30
(3/16 WIRE)	39.77	376.27	-9.69	2053.69	10.38	-0.95	-74.93	672.50	105.85	641.58	2087.88	113.10	628.40
AACM2	5.83	382.10	-40.00	2013.69	10.74	-0.01	-73.98	730.50	105.22	699.26	2049.62	0.00	628.40
L2 (3/16 WIRE)	31.21	413.31	-8.60	2005.09	11.65	-1.06	-73.97	731.00	105.22	699.75	2047.25	100.42	728.82
L2 (3/16 WIRE)	26.14	439.46	-8.60	1996.49	12.41	-1.20	-72.91	782.50	104.67	750.74	2044.28	100.42	829.25
L2 (3/16 WIRE)	21.52	460.98	-8.60	1987.89	13.05	-1.33	-71.71	834.00	104.11	801.59	2040.64	100.42	929.67
L2 (3/16 WIRE)	17.36	478.34	-8.60	1979.29	13.59	-1.44	-70.38	885.50	103.56	852.31	2036.27	100.42	1030.10
L2 (3/16 WIRE)	13.63	491.97	-8.60	1970.69	14.02	-1.53	-68.94	937.00	103.02	902.91	2031.17	100.42	1130.52
L2 (3/16 WIRE)	10.56	502.53	-8.60	1962.09	14.36	-1.61	-67.40	988.50	102.47	953.42	2025.42	100.42	1230.95
AACM3	1.62	504.15	-40.00	1922.09	14.70	-0.02	-65.79	1040.00	101.93	1003.85	1987.11	0.00	1230.95
L3 (3/16 WIRE)	17.32	521.47	-17.15	1904.94	15.31	-3.64	-65.78	1040.50	101.93	1004.34	1975.02	200.26	1431.21
L3 (3/16 WIRE)	14.65	536.12	-17.15	1887.79	15.85	-3.91	-62.13	1143.20	100.86	1104.47	1962.44	200.26	1631.48
L3 (3/16 WIRE)	12.21	548.33	-17.15	1870.64	16.34	-4.15	-58.22	1245.90	99.79	1204.33	1949.35	200.26	1831.74
L3 (3/16 WIRE)	9.99	558.33	-17.15	1853.48	16.76	-4.36	-54.08	1348.60	98.73	1303.94	1935.75	200.26	2032.01
L3 (3/16 WIRE)	8.04	566.36	-17.15	1836.33	17.14	-4.56	-49.71	1451.30	97.68	1403.33	1921.69	200.26	2232.27
L3 (3/16 WIRE)	6.58	572.94	-17.15	1819.18	17.48	-4.74	-45.15	1554.00	96.64	1502.51	1907.27	200.26	2432.54
L3 (3/16 WIRE)	5.49	578.43	-17.15	1802.03	17.79	-4.91	-40.41	1656.70	95.61	1601.50	1892.59	200.26	2632.80
L3 (3/16 WIRE)	4.50	582.92	-17.15	1784.88	18.09	-5.07	-35.49	1759.40	94.58	1700.31	1877.66	200.26	2833.07
L3 (3/16 WIRE)	3.60	586.53	-17.15	1767.73	18.35	-5.23	-30.42	1862.10	93.56	1798.96	1862.49	200.26	3033.33

L3 (3/16 WIRE)	2.91	589.43	-17.15	1750.58	18.61	-5.37	-25.19	1964.80	92.55	1897.44	1847.15	200.26	3233.60
GLASS SPHERE	10.80	600.23	1680.00	3430.58	9.92	0.00	-19.83	2067.50	91.54	1995.78	3482.69	0.00	3233.60
[CHAIN (3/8)	2.81	603.04	-141.84	3288.74	10.39	-0.49	-19.83	2067.50	91.54	1995.78	3343.57	196.80	3430.40
AACM4	0.23	603.27	-40.00	3248.74	10.52	-0.01	-19.33	2097.50	91.54	2025.28	3304.27	0.00	3430.40
L4 (9/16 DACRON)	5.12	608.39	-8.32	3240.42	10.63	-1.62	-19.32	2098.00	91.54	2025.78	3297.04	135.13	3565.53
L4 (9/16 DACRON)	5.12	613.52	-8.32	3232.10	10.75	-1.66	-17.70	2192.50	82.94	2127.26	3289.82	135.13	3700.67
L4 (9/16 DACRON)	5.12	618.64	-8.32	3223.79	10.86	-1.69	-16.04	2287.00	74.34	2228.70	3282.61	135.13	3835.80
L4 (9/16 DACRON)	5.12	623.77	-8.32	3215.47	10.98	-1.73	-14.35	2381.50	65.76	2330.09	3275.42	135.13	3970.94
L4 (9/16 DACRON)	5.12	628.89	-8.32	3207.16	11.09	-1.77	-12.62	2476.00	57.18	2431.44	3268.23	135.13	4106.07
L4 (9/16 DACRON)	4.99	633.88	-8.32	3198.84	11.21	-1.80	-10.86	2570.50	48.61	2532.74	3261.04	135.13	4241.21
L4 (9/16 DACRON)	4.67	638.54	-8.32	3190.52	11.32	-1.84	-9.05	2665.00	40.05	2634.00	3253.79	135.13	4376.34
L4 (9/16 DACRON)	4.30	642.85	-8.32	3182.21	11.42	-1.87	-7.22	2759.50	31.50	2735.21	3246.49	135.13	4511.47
L4 (9/16 DACRON)	3.96	646.80	-8.32	3173.89	11.52	-1.90	-5.34	2854.00	22.96	2836.38	3239.13	135.13	4646.61
L4 (9/16 DACRON)	3.62	650.43	-8.32	3165.57	11.61	-1.93	-3.44	2948.50	14.43	2937.51	3231.70	135.13	4781.74
GLASS SPHERE	0.69	651.12	168.00	3333.57	11.05	0.00	-1.51	3043.00	5.90	3038.60	3396.57	0.00	4781.74
CHAIN (3/8)	0.18	651.30	-14.18	3319.39	11.10	-0.06	-1.51	3043.00	5.90	3038.60	3382.68	19.68	4801.42
(3/8 WIRE)	0.67	651.97	-13.79	3305.60	11.16	-0.42	-1.45	3046.00	5.90	3041.54	3369.28	171.60	4973.02
SEDIMENT TRAP	1.59	653.56	-110.00	3195.60	11.56	0.00	-1.04	3068.00	5.78	3063.26	3261.74	0.00	4973.02
GLASS SPHERE	2.07	655.64	504.00	3699.60	10.05	0.00	-1.04	3068.00	5.78	3063.26	3757.24	0.00	4973.02
CHAIN (3/8)	0.54	656.18	-42.55	3657.04	10.17	-0.14	-1.04	3068.00	5.78	3063.26	3715.44	59.04	5032.06
AACM5	0.15	656.32	-40.00	3617.04	10.28	-0.01	-0.89	3077.00	5.78	3072.11	3676.11	0.00	5032.06
DOUBLE RELEASE	1.13	657.45	-140.00	3477.04	10.71	-0.03	-0.89	3077.50	5.78	3072.61	3538.65	2000.00	7032.06
NYLON (3/4)	2.25	659.70	-1.55	3475.49	10.75	-0.44	-0.85	3079.50	5.78	3074.57	3537.55	63.50	7095.56
CHAIN (1/2)	1.60	661.30	-161.62	3313.87	11.28	-0.39	-0.41	3104.50	0.00	3104.91	3379.21	157.40	7252.96
ANCHOR MACE	0.00	661.30	-5300.00	-1986.13	-18.41	-0.03	-0.03	3124.50	0.00	3124.53	2093.33	1974.00	9226.96
PARACHUTE 7FT	0.00	661.30	0.00	-1986.13	0.00	0.00	0.00	3125.00	0.00	3125.00	2093.33	100.00	9326.96

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WARNING
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ELEMENT 44 HAS INADEQUATE BOUYANCY TO LIFT EVERYTHING IF ADJACENT FLOATATION BROKE OFF.

RSUM= -402.98
BMWT= 168.00
28

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MOORING PERFORMANCE WITHOUT PARACHUTE
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1

NAME	DRAG	SUMD	BMWT	SUMBMW	THETA	DELH	SUMDH	DEPTH	SUMDELL	TRUED	TENSION	COST	TOTAL $
ADCP-FISH	31.68	31.68	200.00	200.00	9.00	-0.01	-77.49	406.00	112,25	371.24	202.49	0.00	0.00
L1 (1/4 WIRE)	20.45	52.13	-2.85	197.15	14.81	-0.33	-77.48	406.50	112.25	371.73	203.93	20.00	20.00
SYN 60	117.36	169.49	1950.00	2147.15	4.51	-0.00	-77.15	416.50	112.24	381.40	2153.83	0.00	20.00
(3/16 WIRE)	4.92	174.41	-0.50	2146.65	4.64	-0.01	-77.14	418.00	112.24	382.90	2153.72	5.85	25.85
*(3/16 FAIR)	4.84	179.25	-1.22	2145.43	4.78	-0.02	-77.13	421.00	112.21	385.92	2152.91	13.65	39.50
AACM1	14.54	193.80	-40.00	2105.43	5.26	-0.00	-77.11	428.00	112.13	392.98	2114.33	0:00	39.50
L1 *(3/16 FAIR)	29.70	223.49	-8.09	2097.34	6.08	-0.26	-77.11	428.50	112.13	393.47	2109.21	90.67	130.17
L1 *(3/16 FAIR)	25.10	248.60	-8.09	2089.25	6.79	-0.33	-76.85	475.00	111.61	440.23	2103.99	90.67	220.85
L1 *(3/16 FAIR)	21.58	270.18	-8.09	2081.16	7.40	-0.39	-76.52	521.50	111.09	486.92	2098.62	90.67	311.52
L1 *(3/16 FAIR)	19.09	289.26	-8.09	2073.06	7.94	-0.45	-76.13	568.00	110.58	533.55	2093.15	90.67	402.20
(3/16 WIRE)	47.23	336.50	-9.69	2063.38	9.26	-0.76	-75.69	614.50	110.06	580.12	2090.64	113.10	515.30
(3/16 WIRE)	39.77	376.27	-9.69	2053.69	10.38	-0.95	-74.93	672.50	109.42	638.00	2087.88	113.10	628.40
AACM2	5.83	382.10	-40.00	2013.69	10.74	-0.01	-73.98	730.50	108.78	695.69	2049.62	0.00	628.40
L2 (3/16 WIRE)	31.21	413.31	-8.60	2005.09	11.65	-1.06	-73.97	731.00	108.78	696.18	2047.25	100.42	728.82
L2 (3/16 WIRE)	26.14	439.46	-8.60	1996.49	12.41	-1.20	-72.91	782.50	108.22	747.19	2044.28	100.42	829.25
L2 (3/16 WIRE)	21.52	460.98	-8.60	1987.89	13.05	-1.33	-71.71	834.00	107.65	798.05	2040.64	100.42	929.67
L2 (3/16 WIRE)	17.36	478.34	-8.60	1979.29	13.59	-1.44	-70.38	885.50	107.09	848.78	2036.27	100.42	1030.10
L2 (3/16 WIRE)	13.63	491.97	-8.60	1970.69	14.02	-1.53	-68.94	937.00	106.53	899.40	2031.17	100.42	1130.52
L2 (3/16 WIRE)	10.56	502.53	-8.60	1962.09	14.36	-1.61	-67.40	988.50	105.97	949.92	2025.42	100.42	1230.95
AACM3	1.62	504.15	-40.00	1922.09	14.70	-0.02	-65.79	1040.00	105.42	1000.37	1987.11	0.00	1230.95
L3 (3/16 WIRE)	17.32	521.47	-17.15	1904.94	15.31	-3.64	-65.78	1040.50	105.42	1000.85	1975.02	200.26	1431.21
L3 (3/16 WIRE)	14.65	536.12	-17.15	1887.79	15.85	-3.91	-62.13	1143.20	104.31	1101.01	1962.44	200.26	1631.48
L3 (3/16 WIRE)	12.21	548.33	-17.15	1870.64	16.34	-4.15	-58.22	1245.90	103.21	1200.91	1949.35	200.26	1831.74
L3 (3/16 WIRE)	9.99	558.33	-17.15	1853.48	16.76	-4.36	-54.08	1348.60	102.12	1300.55	1935.75	200.26	2032.01
L3 (3/16 WIRE)	8.04	566.36	-17.15	1836.33	17.14	-4.56	-49.71	1451.30	101.04	1399.97	1921.69	200.26	2232.27
L3 (3/16 WIRE)	6.58	572.94	-17.15	1819.18	17.48	-4.74	-45.15	1554.00	99.96	1499.19	1907.27	200.26	2432.54
L3 (3/16 WIRE)	5.49	578.43	-17.15	1802.03	17.79	-4.91	-40.41	1656.70	98.89	1598.21	1892.59	200.26	2632.80
L3 (3/16 WIRE)	4.50	582.92	-17.15	1784.88	18.09	-5.07	-35.49	1759.40	97.83	1697.06	1877.66	200.26	2833.07
L3 (3/16 WIRE)	3.60	586.53	-17.15	1767.73	18.35	-5.23	-30.42	1862.10	96.78	1795.74	1862.49	200.26	3033.33
L3 (3/16 WIRE)	2.91	589.43	-17.15	1750.58	18.61	-5.37	-25.19	1964.80	95.73	1894.26	1847.15	200.26	3233.60
GLASS SPHERE	10.80	600.23	1680.00	3430.58	9.92	0.00	-19.83	2067.50	94.69	1992.63	3482.69	0.00	3233.60
CHAIN (3/8)	2.81	603.04	-141.84	3288.74	10.39	-0.49	-19.83	2067.50	94.69	1992.63	3343.57	196.80	3430.40

AACM4	0.23	603.27	-40.00	3248.74	10.52	-0.01	-19.33	2097.50	94.69	2022.14	3304.27	0.00	3430.40
L4 (9/16 DACRON)	5.12	608.39	-8.32	3240.42	10.63	-1.62	-19.32	2098.00	94.69	2022.63	3297.04	135.13	3565.53
L4 (9/16 DACRON)	5.12	613.52	-8.32	3232.10	10.75	-1.66	-17.70	2192.50	85.81	2124.39	3289.82	135.13	3700.67
L4 (9/16 DACRON)	5.12	618.64	-8.32	3223.79	10.86	-1.69	-16.04	2287.00	76.93	2226.11	3282.61	135.13	3835.80
L4 (9/16 DACRON)	5.12	623.77	-8.32	3215.47	10.98	-1.73	-14.35	2381.50	68.06	2327.79	3275.42	135.13	3970.94
L4 (9/16 DACRON)	5.12	628.89	-8.32	3207.16	11.09	-1.77	-12.62	2476.00	59.19	2429.42	3268.23	135.13	4106.07
L4 (9/16 DACRON)	4.99	633.88	-8.32	3198.84	11.21	-1.80	-10.86	2570.50	50.34	2531.02	3261.04	135.13	4241.21
L4 (9/16 DACRON)	4.67	638.54	-8.32	3190.52	11.32	-1.84	-9.05	2665.00	41.48	2632.57	3253.79	135.13	4376.34
L4 (9/16 DACRON)	4.30	642.85	-8.32	3182.21	11.42	-1.87	-7.22	2759.50	32.64	2734.08	3246.49	135.13	4511.47
L4 (9/16 DACRON)	3.96	646.80	-8.32	3173.89	11.52	-1.90	-5.34	2854.00	23.80	2835.54	3239.13	135.13	4646.61
L4 (9/16 DACRON)	3.62	650.43	-8.32	3165.57	11.61	-1.93	-3.44	2948.50	14.96	2936.98	3231.70	135.13	4781.74
GLASS SPHERE	0.69	651.12	168.00	3333.57	11.05	0.00	-1.51	3043.00	6.13	3038.37	3396.57	0.00	4781.74
CHAIN (3/8)	0.18	651.30	-14.18	3319.39	11.10	-0.06	-1.51	3043.00	6.13	3038.37	3382.68	19.68	4801.42
(3/8 WIRE)	0.67	651.97	-13.79	3305.60	11.16	-0.42	-1.45	3046.00	6.13	3041.32	3369.28	171.60	4973.02
SEDIMENT TRAP	1.59	653.56	-110.00	3195.60	11.56	0.00	-1.04	3068.00	6.00	3063.03	3261.74	0.00	4973.02
GLASS SPHERE	2.07	655.64	504.00	3699.60	10.05	0.00	-1.04	3068.00	6.00	3063.03	3757.24	0.00	4973.02
CHAIN (3/8)	0.54	656.18	-42.55	3657.04	10.17	-0.14	-1.04	3068.00	6.00	3063.03	3715.44	59.04	5032.06
AACM5	0.15	656.32	-40.00	3617.04	10.28	-0.01	-0.89	3077.00	6.00	3071.89	3676.11	0.00	5032.06
DOUBLE RELEASE	1.13	657.45	-140.00	3477.04	10.71	-0.03	-0.89	3077.50	6.00	3072.38	3538.65	2000.00	7032.06
NYLON (3/4)	2.25	659.70	-1.55	3475.49	10.75	-0.44	-0.85	3079.50	6.00	3074.35	3537.55	63.50	7095.56
CHAIN (1/2)	1.60	661.30	-161.62	3313.87	11.28	-0.39	-0.41	3104.50	0.00	3104.91	3379.21	157.40	7252.96
ANCHOR MACE	0.00	661.30	-5300.00	-1986.13	-18.41	-0.03	-0.03	3124.50	0.00	3124.53	2093.33	1974.00	9226.96

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WARNING

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ELEMENT 44 HAS INADEQUATE BOUYANCY TO LIFT EVERYTHING IF ADJACENT FLOATATION BROKE OFF.

RSUM= -402.98
BMWT= 168.00
28

4. Launch performance

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       LAUNCH PERFORMANCE WITH PARACHUTE
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1 NAME	KD	SUMKD	BMWT	SUMBMW	VI	TFINAL
ADCP-FISH	0.6600E-02	0.2825E+00	200.00	-1986.13	83.85	0.00
L1 (1/4 WIRE)	0.1060E-03	0.2759E+00	-2.85	-2186.13	89.01	246.40
SYN 60	0.8150E-02	0.2758E+00	1950.00	-2183.28	88.97	244.30
(3/16 WIRE)	0.2610E-04	0.2677E+00	-0.50	-4133.28	124.27	2251.59
*(3/16 FAIR)	0.1890E-03	0.2676E+00	-1.22	-4132.78	124.27	2251.27
AACM1	0.9830E-02	0.2674E+00	-40.00	-4131.56	124.29	2251.38
L1 *(3/16 FAIR)	0.1255E-02	0.2576E+00	-8.09	-4091.56	126.03	2280.49
L1 *(3/16 FAIR)	0.1255E-02	0.2564E+00	-8.09	-4083.47	126.21	2281.23
L1 *(3/16 FAIR)	0.1255E-02	0.2551E+00	-8.09	-4075.38	126.40	2281.96
L1 *(3/16 FAIR)	0.1255E-02	0.2538E+00	-8.09	-4067.29	126.58	2282.70
(3/16 WIRE)	0.5046E-03	0.2526E+00	-9.69	-4059.20	126.77	2283.43
(3/16 WIRE)	0.5046E-03	0.2521E+00	-9.69	-4049.51	126.75	2277.29
AACM2	0.9830E-02	0.2516E+00	-40.00	-4039.83	126.72	2271.15
L2 (3/16 WIRE)	0.4480E-03	0.2417E+00	-8.60	-3999.83	128.63	2300.26
L2 (3/16 WIRE)	0.4480E-03	0.2413E+00	-8.60	-3991.22	128.61	2294.81
L2 (3/16 WIRE)	0.4480E-03	0.2408E+00	-8.60	-3982.62	128.59	2289.36
L2 (3/16 WIRE)	0.4480E-03	0.2404E+00	-8.60	-3974.02	128.57	2283.91
L2 (3/16 WIRE)	0.4480E-03	0.2400E+00	-8.60	-3965.42	128.55	2278.46
L2 (3/16 WIRE)	0.4480E-03	0.2395E+00	-8.60	-3956.82	128.53	2273.01
AACM3	0.9830E-02	0.2391E+00	-40.00	-3948.22	128.51	2267.56
L3 (3/16 WIRE)	0.8935E-03	0.2292E+00	-17.15	-3908.22	130.57	2296.67
L3 (3/16 WIRE)	0.8935E-03	0.2283E+00	-17.15	-3891.07	130.54	2285.80
L3 (3/16 WIRE)	0.8935E-03	0.2274E+00	-17.15	-3873.92	130.51	2274.93
L3 (3/16 WIRE)	0.8935E-03	0.2265E+00	-17.15	-3856.77	130.48	2264.06
L3 (3/16 WIRE)	0.8935E-03	0.2257E+00	-17.15	-3839.62	130.44	2253.19
L3 (3/16 WIRE)	0.8935E-03	0.2248E+00	-17.15	-3822.46	130.41	2242.32
L3 (3/16 WIRE)	0.8935E-03	0.2239E+00	-17.15	-3805.31	130.38	2231.45
L3 (3/16 WIRE)	0.8935E-03	0.2230E+00	-17.15	-3788.16	130.34	2220.58
L3 (3/16 WIRE)	0.8935E-03	0.2221E+00	-17.15	-3771.01	130.31	2209.71
L3 (3/16 WIRE)	0.8935E-03	0.2212E+00	-17.15	-3753.86	130.27	2198.84
GLASS SPHERE	0.7380E-01	0.2203E+00	1680.00	-3736.71	130.24	2187.97

CHAIN (3/8)	0.1620E-02	0.1465E+00	-141.84	-5416.71	192.29	4386.81
AACM4	0.9830E-02	0.1449E+00	-40.00	-5274.87	190.82	4256.36
L4 (9/16 DACRON)	0.1701E-02	0.1350E+00	-8.32	-5234.87	196.89	4285.47
L4 (9/16 DACRON)	0.1701E-02	0.1333E+00	-8.32	-5226.55	197.98	4289.11
L4 (9/16 DACRON)	0.1701E-02	0.1316E+00	-8.32	-5218.23	199.10	4292.75
L4 (9/16 DACRON)	0.1701E-02	0.1299E+00	-8.32	-5209.92	200.24	4296.39
L4 (9/16 DACRON)	0.1701E-02	0.1282E+00	-8.32	-5201.60	201.40	4300.04
L4 (9/16 DACRON)	0.1701E-02	0.1265E+00	-8.32	-5193.29	202.59	4303.68
L4 (9/16 DACRON)	0.1701E-02	0.1248E+00	-8.32	-5184.97	203.80	4307.32
L4 (9/16 DACRON)	0.1701E-02	0.1231E+00	-8.32	-5176.65	205.04	4310.96
L4 (9/16 DACRON)	0.1701E-02	0.1214E+00	-8.32	-5168.34	206.30	4314.61
L4 (9/16 DACRON)	0.1701E-02	0.1197E+00	-8.32	-5160.02	207.60	4318.25
GLASS SPHERE	0.7380E-02	0.1180E+00	168.00	-5151.70	208.92	4321.89
CHAIN (3/8)	0.1620E-03	0.1107E+00	-14.18	-5319.70	219.26	4541.77
(3/8 WIRE)	0.2662E-03	0.1105E+00	-13.79	-5305.52	219.13	4528.73
SEDIMENT TRAP	0.2453E-02	0.1102E+00	-110.00	-5291.72	219.11	4516.81
GLASS SPHERE	0.2214E-01	0.1078E+00	504.00	-5181.72	219.27	4424.05
CHAIN (3/8)	0.4860E-03	0.8563E-01	-42.55	-5685.72	257.68	5083.70
AACM5	0.9830E-02	0.8515E-01	-40.00	-5643.17	257.44	5044.57
DOUBLE RELEASE	0.1400E-02	0.7532E-01	-140.00	-5603.17	272.76	5073.67
NYLON (3/4)	0.6050E-03	0.7392E-01	-1.55	-5463.17	271.87	4943.52
CHAIN (1/2)	0.1440E-02	0.7331E-01	-161.62	-5461.62	272.95	4946.22
ANCHOR MACE	0.1180E-01	0.7187E-01	-5300.00	-5300.00	271.56	4794.72
PARACHUTE 7FT	0.6007E-01	0.6007E-01	0.00	0.00	0.00	-422.29

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LAUNCH PERFORMANCE WITHOUT PARACHUTE

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1 NAME	KD	SUMKD	BMWT	SUMBMW	VI	TFINAL
ADCP-FISH	0.6600E-02	0.2224E+00	200.00	-1986.13	94.49	0.00
L1 (1/4 WIRE)	0.1060E-03	0.2158E+00	-2.85	-2186.13	100.64	258.93
SYN 60	0.8150E-02	0.2157E+00	1950.00	-2183.28	100.60	257.03
(3/16 WIRE)	0.2610E-04	0.2076E+00	-0.50	-4133.28	141.11	2279.80
*(3/16 FAIR)	0.1890E-03	0.2076E+00	-1.22	-4132.78	141.11	2279.53
AACM1	0.9830E-02	0.2074E+00	-40.00	-4131.56	141.15	2280.00
L1 *(3/16 FAIR)	0.1255E-02	0.1975E+00	-8.09	-4091.56	143.92	2327.77
L1 *(3/16 FAIR)	0.1255E-02	0.1963E+00	-8.09	-4083.47	144.24	2330.88
L1 *(3/16 FAIR)	0.1255E-02	0.1950E+00	-8.09	-4075.38	144.56	2334.00
L1 *(3/16 FAIR)	0.1255E-02	0.1938E+00	-8.09	-4067.29	144.88	2337.12
(3/16 WIRE)	0.5046E-03	0.1925E+00	-9.69	-4059.20	145.21	2340.24
(3/16 WIRE)	0.5046E-03	0.1920E+00	-9.69	-4049.51	145.22	2335.06
AACM2	0.9830E-02	0.1915E+00	-40.00	-4039.83	145.24	2329.88
L2 (3/16 WIRE)	0.4480E-03	0.1817E+00	-8.60	-3999.83	148.38	2377.65
L2 (3/16 WIRE)	0.4480E-03	0.1812E+00	-8.60	-3991.22	148.40	2373.05
L2 (3/16 WIRE)	0.4480E-03	0.1808E+00	-8.60	-3982.62	148.42	2368.45
L2 (3/16 WIRE)	0.4480E-03	0.1803E+00	-8.60	-3974.02	148.45	2363.85
L2 (3/16 WIRE)	0.4480E-03	0.1799E+00	-8.60	-3965.42	148.47	2359.25
L2 (3/16 WIRE)	0.4480E-03	0.1794E+00	-8.60	-3956.82	148.50	2354.65
AACM3	0.9830E-02	0.1790E+00	-40.00	-3948.22	148.52	2350.05
L3 (3/16 WIRE)	0.8935E-03	0.1692E+00	-17.15	-3908.22	152.00	2397.82
L3 (3/16 WIRE)	0.8935E-03	0.1683E+00	-17.15	-3891.07	152.07	2388.64
L3 (3/16 WIRE)	0.8935E-03	0.1674E+00	-17.15	-3873.92	152.14	2379.47
L3 (3/16 WIRE)	0.8935E-03	0.1665E+00	-17.15	-3856.77	152.21	2370.30
L3 (3/16 WIRE)	0.8935E-03	0.1656E+00	-17.15	-3839.62	152.28	2361.12
L3 (3/16 WIRE)	0.8935E-03	0.1647E+00	-17.15	-3822.46	152.35	2351.95
L3 (3/16 WIRE)	0.8935E-03	0.1638E+00	-17.15	-3805.31	152.42	2342.78
L3 (3/16 WIRE)	0.8935E-03	0.1629E+00	-17.15	-3788.16	152.49	2333.60
L3 (3/16 WIRE)	0.8935E-03	0.1620E+00	-17.15	-3771.01	152.56	2324.43
L3 (3/16 WIRE)	0.8935E-03	0.1611E+00	-17.15	-3753.86	152.64	2315.25
GLASS SPHERE	0.7380E-01	0.1602E+00	1680.00	-3736.71	152.71	2306.08
CHAIN (3/8)	0.1620E-02	0.8643E-01	-141.84	-5416.71	250.35	4645.03
AACM4	0.9830E-02	0.8481E-01	-40.00	-5274.87	249.40	4517.65

L4 (9/16 DACRON)	0.1701E-02	0.7498E-01	-8.32	-5234.87	264.24	4565.42
L4 (9/16 DACRON)	0.1701E-02	0.7328E-01	-8.32	-5226.55	267.07	4572.29
L4 (9/16 DACRON)	0.1701E-02	0.7157E-01	-8.32	-5218.23	270.01	4579.16
L4 (9/16 DACRON)	0.1701E-02	0.6987E-01	-8.32	-5209.92	273.06	4586.03
L4 (9/16 DACRON)	0.1701E-02	0.6817E-01	-8.32	-5201.60	276.23	4592.91
L4 (9/16 DACRON)	0.1701E-02	0.6647E-01	-8.32	-5193.29	279.51	4599.78
L4 (9/16 DACRON)	0.1701E-02	0.6477E-01	-8.32	-5184.97	282.93	4606.65
L4 (9/16 DACRON)	0.1701E-02	0.6307E-01	-8.32	-5176.65	286.49	4613.52
L4 (9/16 DACRON)	0.1701E-02	0.6137E-01	-8.32	-5168.34	290.20	4620.39
L4 (9/16 DACRON)	0.1701E-02	0.5967E-01	-8.32	-5160.02	294.07	4627.26
GLASS SPHERE	0.7380E-02	0.5797E-01	168.00	-5151.70	298.12	4634.13
CHAIN (3/8)	0.1620E-03	0.5059E-01	-14.18	-5319.70	324.29	4868.03
(3/8 WIRE)	0.2662E-03	0.5042E-01	-13.79	-5305.52	324.37	4855.29
SEDIMENT TRAP	0.2453E-02	0.5016E-01	-110.00	-5291.72	324.81	4843.87
GLASS SPHERE	0.2214E-01	0.4771E-01	504.00	-5181.72	329.57	4755.77
CHAIN (3/8)	0.4860E-03	0.2557E-01	-42.55	-5685.72	471.59	5457.46
AACM5	0.9830E-02	0.2508E-01	-40.00	-5643.17	474.36	5419.24
DOUBLE RELEASE	0.1400E-02	0.1525E-01	-140.00	-5603.17	606.17	5467.01
NYLON (3/4)	0.6050E-03	0.1385E-01	-1.55	-5463.17	628.07	5339.51
CHAIN (1/2)	0.1440E-02	0.1324E-01	-161.62	-5461.62	642.16	5343.36
ANCHOR MACE	0.1180E-01	0.1180E-01	-5300.00	-5300.00	670.07	5194.60

APPENDIX F

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C*******
C*******                   MOORING.TEST.F77
C*******
C******* PROGRAM TO TEST CURRENT METER MOORING DESIGNS FOR
C******* USE IN THE GULF STREAM.  USER CAN SPECIFY DIFFERENT VELOCITY
C******* PROFILES AS WELL AS DIFFERENT MOORING ELEMENTS.
C******* SEPTEMBER 1983, MODIFIED IN JULY 1986
      REAL*4 RSUM,TEMPBMW
      REAL*4 KD(50),VEL(100),KDSEG(100),BMWUN(100),KDUN(100)
      REAL*4 TFINAL(100),TDEPTH(100),TEMPKD,VSINK,LSEG(100)
      REAL*4 CP(50),CE(50),CPSEG(100),CESEG(100),DELL(100),SUMDELL(100)
      REAL*4 U(50),ZU(50),Z(50),DF(50),L(50),BMW(50),PRICE(50)
      REAL*4 DEG(100),SUMCST(100)
      REAL*4 SAVL(100),LF,ZSEG(50),USEG(50),UBAR(100),SUMDH(100)
      REAL*4 D(100),BMWT(100),COST(100),SUMD(100),SUMBMW(100)
      REAL*4 THETA(100),TENSE(100),DELH(100),DEPTH(100),TRUED(100)
      INTEGER*2 ISEQ(50),ILINE(50),NSEG(50),NTIMES(50),NSEGSEG(100)
      INTEGER*2 POS,NUMEL,FLAG,LDUM
      CHARACTER*20 SAVNM(100),NAME(50)
      DATA NCT/0/
      CALL INFILE(KCTRL1)
      CALL INFILE(KCTRL2)
      READ(KCTRL1,5,END=10) (U(I),ZU(I),I=1,50)
    5 FORMAT(2F10.2)
   10 IU=I-1
      READ(KCTRL2,15,END=20) (ISEQ(I),NAME(I),ILINE(I),NSEG(I),
     @ NTIMES(I),Z(I),DF(I),L(I),BMW(I),PRICE(I),KD(I),CP(I),CE(I),
     @ I=1,50)
   15 FORMAT(I2,A20,3I2,F6.0,E12.4,F7.1,F9.3,F8.2,3E11.4)
   20 IPTS=I-1
       NUMEL=IPTS
      DBOT=Z(IPTS)
C******* MAIN DOWNWARD PROCESSING LOOP
      DO 500 LP=1,IPTS
      IF(NSEG(LP) .EQ. 0) NSEG(LP)=1
      IF(NTIMES(LP) .EQ. 0) NTIMES(LP)=1
      LF=1.
      IF(ILINE(LP)) 30,30,25
   25 LF=L(LP)/NSEG(LP)
      IF(NSEG(LP)-1) 30,30,40
C******* DO THE FOLLOWING SEARCH FOR VELOCITY IF NOT WIRE
   30 CONTINUE
      NCT=NCT+1
      SAVL(NCT)=L(LP)
      SAVNM(NCT)=NAME(LP)
      DO 36 I=1,IU
      DELZ=Z(LP)-ZU(I)
      IF(DELZ) 34,32,36
   32 UBAR(NCT)=U(I)
      GO TO 150
```

```
   34 UBAR(NCT)=U(I)+(U(I)-U(I-1))*DELZ/(ZU(I)-ZU(I-1))
      GO TO 150
   36 CONTINUE
      GO TO 150
C*******  DO THE FOLLOWING SEARCH FOR VELOCITY IF WIRE
   40 CONTINUE
      NSEG1=NSEG(LP)+1
      ZSEG(1)=Z(LP)
      DO 120 K=1,NSEG1
      IF(K.EQ.1) GO TO 102
      ZSEG(K)=ZSEG(K-1)+LF
  102 DO 110 I=1,IU
      DELZ=ZSEG(K)-ZU(I)
      IF(DELZ) 106,104,110
  104 USEG(K)=U(I)
      GO TO 112
  106 USEG(K)=U(I)+(U(I)-U(I-1))*DELZ/(ZU(I)-ZU(I-1))
      GO TO 112
  110 CONTINUE
  112 IF(K .EQ. 1) GO TO 120
      NCT=NCT+1
      UBAR(NCT)=(USEG(K-1)+USEG(K))*0.5
      SAVL(NCT)=LF
      SAVNM(NCT)=NAME(LP)
  120 CONTINUE
C******* DO THE DOWNWARD SUMMATIONS
  150 FIRST=NCT-NSEG(LP)+1
      DO 200 KDN=FIRST,NCT
      D(KDN)=DF(LP)*LF*UBAR(KDN)*UBAR(KDN)*NTIMES(LP)
      BMWT(KDN)=NTIMES(LP)*BMW(LP)*LF
      COST(KDN)=PRICE(LP)*NTIMES(LP)*LF
      IF(KDN .NE. 1) GO TO 160
      SUMD(KDN)=D(KDN)
      SUMBMW(KDN)=BMWT(KDN)
      SUMCST(KDN)=COST(KDN)
      GO TO 170
  160 SUMD(KDN)=SUMD(KDN-1)+D(KDN)
      SUMBMW(KDN)=SUMBMW(KDN-1)+BMWT(KDN)
      SUMCST(KDN)=SUMCST(KDN-1)+COST(KDN)
  170 TENSE(KDN)=SQRT(SUMD(KDN)*SUMD(KDN)+SUMBMW(KDN)*SUMBMW(KDN))
      THETA(KDN)=ATAN(SUMD(KDN)/SUMBMW(KDN))
  200 CONTINUE
  500 CONTINUE
C******* NOW DO ALL THE UPWARD SUMMATIONS
      DO 600 LP=1,NCT
      LNOW=NCT-LP+1
      DELH(LNOW)=-(1.0-COS(THETA(LNOW)))*SAVL(LNOW)
      IF(LP.NE. 1) GO TO 550
      DEPTH(LNOW)=DBOT-SAVL(LNOW)
      TRUED(LNOW)=DBOT-(SAVL(LNOW)+DELH(LNOW))
      SUMDH(LNOW)=DELH(LNOW)
      GO TO 600
  550 DEPTH(LNOW)=DEPTH(LNOW+1)-SAVL(LNOW)
      TRUED(LNOW)=TRUED(LNOW+1)-(SAVL(LNOW)+DELH(LNOW))
      SUMDH(LNOW)=SUMDH(LNOW+1)+DELH(LNOW)
```

```
      DEG(LNOW)=THETA(LNOW)*180./3.141795
  600 CONTINUE
C******* WRITE IT ALL OUT
      CALL OUTFILE(KOUT)
C***** PRINT HEADING
      FLAG=1
      WRITE(KOUT,850)
  850 FORMAT(//,'*****************************************************'
     @            /'       MOORING PERFORMANCE WITH PARACHUTE',
     @          /'*****************************************************'/)
  855 IF (FLAG.EQ.0) THEN
        NCT=NCT-1
        WRITE(KOUT,860)
  860 FORMAT(//,'*****************************************************'
     @            /'      MOORING PERFORMANCE WITHOUT PARACHUTE',
     @          /'*****************************************************'/)
        GO TO 970
      ENDIF
C***** ANALYSE LAUNCH PERFORMANCE
      I=1
      POS=1
  910 IF ((ILINE(I).EQ.0) .AND. (I.LE.NUMEL)) THEN
            KDSEG(POS)=KD(I)*NTIMES(I)
             POS=POS+1
         I=I+1
         GO TO 910
      ELSE
         IF (ILINE(I).EQ.1) THEN
         DO 960 J=1,NSEG(I)
            KDSEG(POS)=KD(I)*L(I)/NSEG(I)
             POS=POS+1
  960    CONTINUE
         I=I+1
         GO TO 910
         ENDIF
      ENDIF
  970 TEMPBMW=0.0
      TEMPKD=0.0
      DO 1000 I=NCT,1,-1
         BMWUN(I)=TEMPBMW+BMWT(I)
          TEMPBMW=BMWUN(I)
         KDUN(I)=TEMPKD+KDSEG(I)
          TEMPKD=KDUN(I)
         VEL(I)=SQRT(ABS(BMWUN(I)/KDUN(I)))
 1000 CONTINUE
      VSINK=VEL(1)
      DO 1100 I=1,NCT
         TFINAL(I)=-(BMWUN(I)+KDUN(I)*VSINK**2)
 1100 CONTINUE
C***** OBTAIN STRETCHED VERSION OF MOORING
      POS=1
      I=1
 1400  DO 1450 J=1,NSEG(I)
        CPSEG(POS)=CP(I)
        CESEG(POS)=CE(I)
```

```
        LSEG(POS)=L(I)
        NSEGSEG(POS)=NSEG(I)
        POS=POS+1
 1450  CONTINUE
      I=I+1
      IF (I.LE.NUMEL) GO TO 1400
      DO 1500 I=NCT,1,-1
        DELL(I)=(CPSEG(I)*TFINAL(I)+CESEG(I)*TENSE(I))*LSEG(I)
        DELL(I)=DELL(I)/NSEGSEG(I)
        DELL(I)=DELL(I)*COS(THETA(I))
 1500 CONTINUE
      DELTEMP=0.0
      DO 1600 I=NCT,1,-1
        SUMDELL(I)=DELTEMP+DELL(I)
       DELTEMP=SUMDELL(I)
        TDEPTH(I)=TRUED(I)-SUMDELL(I)
 1600 CONTINUE .
      WRITE(KOUT,800) (SAVNM(J),D(J),SUMD(J),BMWT(J),SUMBMW(J),
     @DEG(J),DELH(J),SUMDH(J),DEPTH(J),SUMDELL(J),TDEPTH(J),TENSE(J),
     @SUMCST(J),J=1,NCT)
  800 FORMAT('1',T9,'NAME',T25,'DRAG',T34,'SUMD',T43,'BMWT',T50,
     @ 'SUMBMW',T59,'THETA',T68,'DELH',T75,'SUMDH',T83,'DEPTH',T90,
     @ 'SUMDELL',T100,'TRUED',T107,'TENSION',T118,
     @ 'TOTAL $$',
     @ //(1X,A20,2F8.2,2F9.2,5F8.2,3F9.2))
C******             CHECK BOUYANCY OF GLASS SPHERES FOR RETREIVAL
        DO 700 I=2,NCT
          IF (BMWT(I) .GT. 0) THEN
             LAD=I-1
             RSUM=0.0
  710        IF (BMWT(LAD).GT.0) THEN
               GO TO720
             ELSE
                RSUM=RSUM+BMWT(LAD)
                LAD=LAD-1
                GO TO710
             ENDIF
  720        LAD=I+1
  730 IF (FLAG.EQ.0) THEN
        LDUM=NCT-3
      ELSE
        LDUM=NCT-4
      ENDIF
             IF  ((LAD .LE. LDUM) .AND. (BMWT(LAD).LT.0)) THEN
                RSUM =RSUM+BMWT(LAD)
                LAD=LAD+1
                GO TO730
             ELSE
                GO TO740
             ENDIF
  740        IF (BMWT(I) .LT. ABS(RSUM))    THEN
               WRITE(KOUT,755)
               WRITE(KOUT,756)
               WRITE(KOUT,757)
               WRITE(KOUT,770) I
```

```
              WRITE(KOUT,780) RSUM, BMWT(I),NUMEL
 755 FORMAT('******************')
 756 FORMAT('     WARNING      ')
 757 FORMAT('******************')
 770 FORMAT(/ 'ELEMENT ',I2,' HAS INADEQUATE BOUYANCY TO LIFT ',
    @       'EVERYTHING IF ADJACENT FLOATATION BROKE OFF.')
 780 FORMAT(// 'RSUM=',F9.2,/ 'BMWT=',F9.2/,I2)
            ENDIF
         ENDIF
 700  CONTINUE
     IF (FLAG.EQ.1) THEN
     WRITE(KOUT,1150)
1150 FORMAT(//,'*****************************************************'
    @             /'        LAUNCH PERFORMANCE WITH PARACHUTE',
    @           /'*****************************************************'/)
     ELSE
     WRITE(KOUT,1160)
1160 FORMAT(//,'*****************************************************'
    @             /'        LAUNCH PERFORMANCE WITHOUT PARACHUTE',
    @           /'*****************************************************'/)
     ENDIF
     WRITE(KOUT,1200) (SAVNM(J),KDSEG(J),KDUN(J),BMWT(J),
    @                 BMWUN(J),VEL(J),TFINAL(J),J=1,NCT)
1200 FORMAT('1',T9,'NAME',T25,'KD',T37,'SUMKD',T49,'BMWT',
    @        T57,'SUMBMW',T69,'VI',
    @       T78,'TFINAL',//(1X,A20,2E12.4,4F9.2))
     IF (FLAG.EQ.1) THEN
      FLAG=0
      GO TO 855
     ENDIF
     STOP
     END
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A computer program for the static analysis of a current meter mooring has been developed to help oceanographers design high performance mooring systems with Gulf Stream applications particularly in mind. This report specifically documents current meter mooring design for moorings launched November 1986 in the Gulf Stream off Cape Hatteras in a SYNOP (Synoptic Ocean Prediction) Pilot Experiment. It describes in detail how to evaluate the computer program solution.

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