ANGULAR DISTRIBUTION OF PRESSURE
ON A CYLINDER OSCILLATING
SINUSOIDALLY IN WATER

A Thesis

Presented to

The Faculty of the Department of Mechanical Engineering

University of Houston

In Partial Fulfillment

of the Requirements for the Degree

Master of Science in Mechanical Engineering

---

by

Bancha Chantranuvatana

December, 1974

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ABSTRACT

In this study, an investigation of the variation of the unsteady pressure distribution around a circular cylinder was conducted. The model was oscillated sinusoidally in a water tank by means of a scotch yoke.

The instantaneous pressures were measured by means of miniature strain gage pressure transducers. Ranges of oscillatory speeds were from 9.8 to 58.6 cycles per minute with amplitudes of oscillation of 1, 2, 4 and 6 inches.

A series of time-dependent unsteady distributions of circumferential pressure are presented in the form of diagrams of pressure coefficients versus angular position about the cylinder wall from 0 to 180 degrees. The pressure drag was determined by integration of the pressure coefficient. The magnitude of the forces were found to depend on the amplitudes of oscillations and frequencies of the displacements of the amplitudes and frequencies of oscillations of the cylinder. These results are consistent with what could be anticipated in advance.

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CHAPTER I

INTRODUCTION

General concepts

Forces exerted on a body by a moving fluid may be resolved into two components; one (drag) in the direction of relative flow toward the body and one (lift) transverse to the direction of flow. This study will be directed toward an examination of the force acting on a circular cylinder executing oscillatory motion in a fluid which is otherwise at rest. In this experiment, the average lift force is zero due to the symmetry of the body transverse to the direction of motion. The force parallel to relative fluid motion will be studied in detail in this investigation.

The drag force is generated by fluid velocity parallel to the flow direction and can be divided into two parts, one due to shear stress and one due to pressure. The first part of the force is produced by viscous effects acting on the body and is called force due to skin friction. The part due to pressure distribution is known as form (pressure) drag and is related to the development of the wake region on the downstream part of the body. In a complex-unsteady flow,such as when a circular cylinder accelerates through a fluid otherwise at rest, a force must be exerted in order to accelerate the mass of the cylinder, and an additional force must be exerted in order to accelerate the mass of the fluid affected by the cylinder. This part of the force is typically known as the inertia force. The inertia force depends on the fluid acceleration and, in an oscillatory flow, on the amplitude and frequency of oscillation. The total force on an element of a vertical cylinder in an unsteady flow has been expressed as the sum of the drag and inertia force components. The force due to flüid velocity has been described as

$$F_D = \frac{1}{2} C_D \rho A V^2 \qquad (1)$$

and the force due to fluid acceleration has been expressed as

$$F_I = C_M \rho \forall \frac{\partial V}{\partial t}. \qquad (2)$$

In equations (1) and (2), the following definitions apply:

C_D = coefficient of drag,

C_M = coefficient of mass,

ρ = density of fluid,

V = instantaneous horizontal velocity,

A = projected area perpendicular to the velocity, V,

and

$\forall$ = volume of the fluid displaced by the body.

Based on the analysis of Morison, et al[14], the total force is obtained by adding equations (1) and (2) linearly,

$$F = \frac{1}{2} C_D \rho A V|V| + C_M \rho \forall \frac{\partial V}{\partial t} \qquad (3)$$

The absolute value of the velocity is necessary in the drag-force part so that the drag component is in the same direction as the velocity since the relative flow in an oscillatory motion undergoes periodic reversal. A set of values of C_D and C_M can be found from the analysis of Keulegan[10]. The theoretical (inviscid flow) value for C_M is 2 for a circular cylinder (see Lamb[13]), while the drag coefficient in steady flow is a function of the Reynolds number.

The purpose of this investigation is to measure the circumferential pressure distribution on the surface of a circular cylinder in oscillatory motion. A knowledge of the pressure distribution, which should be the major part of the total force (except for very low velocity), is of great interest to the offshore designer. Generally speaking, knowledge of the pressure distribution is helpful in obtaining an understanding of the forces and moments produced by the fluid on an offshore structure subjected to wave motion.

Literature survey

Many investigations of the hydrodynamic forces acting on a circular cylinder have been conducted in wave tanks in which periodic surface waves can be generated. The majority of these studies were reported in the form of dimensionless parameters, coefficients of drag and inertia, but none considered measurement of the instantaneous pressure distribution to obtain that part of the instantaneous force.

There have been numerous steady flow studies to determine the force acting on a circular cylinder. For example, Grove, et al,[5] conducted an experimental investigation of the steady separated flow past a circular cylinder in an oil tunnel. The pressure distribution on the cylinder surface was measured by a simple manometer technique. The pressure coefficient at any angle θ from the front stagnation point was calculated from

$$C_p = \frac{(p_\theta - p_\infty)}{\frac{1}{2}\rho V^2} \qquad (4)$$

where p_θ = pressure at angle θ,

ρ = fluid density,

p_∞ = upstream pressure,

and

V = free-stream velocity.

The Reynolds numbers were low for the Grove study and the relationship between C_p and $\mathbb{R}$ was found to be

$$C_p = 0.62 + 12.6/\mathbb{R} \quad \text{for} \quad 10 \leqslant \mathbb{R} \leqslant 177.$$

Lagerstrom [11] discusses the drag coefficient variation for Reynolds numbers up to about 10^6. As the subcritical Reynolds number increases, the fraction of the drag coefficient due to pressure increases to about 97 per cent. Lagerstrom notes that, for supercritical flows, the pressure part of the drag coefficient is about 80 per cent.

Achenbach [1] did experiments on circular cylinders in the Reynolds number range $6 \times 10^4 < \mathbb{R} < 5 \times 10^6$. He found that skin friction represented less than 1 per cent of the drag coefficient at $\mathbb{R} = 10^5$, rose to about 2 per cent at $\mathbb{R} = 5 \times 10^5$, and then decreased to about 0.5 per cent at $\mathbb{R} = 5 \times 10^6$. Plots of pressure coefficient versus θ are given for several values of $\mathbb{R}$.

Batham [2] discusses his experiments on smooth and rough circular cylinders in a range of transition Reynolds numbers, $1.11 \times 10^5 < \mathbb{R} < 2.35 \times 10^5$. Batham's pressure coefficients agreed quite closely with those of Achenbach's for the same Reynolds numbers. As valuable as these steady flow studies are, they do not cast any light on the unsteady flow case.

Schwabe [17] measured the pressure distribution around a circular cylinder during the process of acceleration from rest. It was found that the measured pressure coefficient is very close to that in potential flow in the early stages of acceleration but deviates from it as time elapsed. It is expected, from numerous measurements, that there is a negative pressure coefficient in the cylinder wake and large pressure drag will be exerted on the body.

Hamann[6] and Hunt[7] conducted experiments in a water tank in an attempt to describe the unsteady forces that act on a cylinder undergoing oscillatory motion in water. Their results presented only total forces which were measured by means of strain gages. Hunt improved Hamann's analysis by presenting forces with both positive and negative acceleration. Hunt showed that the instantaneous force increases to a maximum in the direction of positive acceleration and decreases uniformly in the negative acceleration region.

Method of analysis

There are many methods which can be used for determining forces. One accurate method of determining form drag is the method wherein the pressure distribution is measured by using miniature strain gage transducers. In fact, very little is known about the pressure distribution around a sinusoidally oscillating circular cylinder. It is the aim of this investigation to evaluate the coefficient of pressure from

$$C_{p(\theta,t)} = \frac{p_{(\theta,t)} - p_\infty}{\frac{1}{2}\rho V_{max.}^2} \qquad (5)$$

where $p_{(\theta,t)}$ is circumferential pressure which is a time-dependent variable

Knowledge of the instantaneous variation of the pressure coefficient will hopefully yield further insight to the prediction of wave forces.

CHAPTER II

EXPERIMENTAL APPARATUS

Water tank and mechanism of the system

The apparatus constructed by Hamann [6] and used by Hunt [7] was utilized. The inside walls of the water tank were recoated with fiberglass. The thickness of the coating is about one quarter of an inch which not only prevents leaking of water through the wooden wall but also provides smoothness of the surface. Alignment of the sliding frame was adjusted and the linear bearings were turned through ten degrees in order to reduce the vibration of the mechanism. Basically, the test unit consists of a variable speed DC motor driving a scotch yoke mechanism. The scotch yoke converts the rotary output of the motor to a sinusoidally oscillating linear motion. A detailed description of the apparatus is found in the theses of Hamann [6] and Hunt [7].

The plan to be followed is to oscillate a cylinder which is rigidly attached to the sliding frame. The pressure is to be measured by means of a small pressure transducer mounted inside the cylinder. A small sensing port extends through the cylinder wall forming a smooth junction on the outside surface of the cylinder. The cylinder will be rotated about its axis through a fixed angular increment after several cycles of oscillatory motion. Continuous measurement of the pressure at each increment will provide the instantaneous pressure distribution as a function of angular position.

Selection of transducer and diaphragm

The pressure distribution was measured by means of a specially designed pressure transducer. This unit is composed of a strain gage attached to a diaphragm mounted in a housing. The strain gages are BLH type FAES - 4-44-35 S 13 with strain gage resistance of 350.0 ohms in each leg. Aluminum was found to have the proper elastic constants to respond to the time-dependant fluid pressure. For small pressure changes, the thickness of the diaphragm can be approximated from the equation of theoretical maximum radial stress σ_r and tangential stress σ_t for a circular-flat-diaphragm. The equation is given by

$$\sigma_r = \sigma_t = \frac{3pR^2}{8t^2}(1+\mu)$$

where R = diaphragm radius

μ = poisson's ratio

p = pressure

t = diaphragm thickness

The selected thickness of the aluminum sheet is 0.005 inch and the diameter of the diaphragm is 0.5 inch. The strain gage was glued on the diaphragm following the direction for making diaphragm strain gages recommended by BLH. The strain gage and diaphragm were clamped and heated in an electric oven for three hours at 350° Fahrenheit .

Due to the small size of the strain gage, a microscope with magnification of 5 was used in soldering the lead connections to the strain gage. The surface of the strain gage was coated with gagekote, a moisture protection from BLH. The assembly of the whole transducer is shown in Figures 1 and 3.

It was expected to use three pairs of transducers but unfortunately only two pairs could be used due to the space limit inside the cylinder. Each pair consisted of an active transducer and a reference (dummy) transducer. The latter had its opening closed and was mounted in the same vertical line as the active transducer. Its duty is to compensate for the inertia effect due to the oscillation of fluid inside the cavity of the transducer. A small hole of 1/64 inch diameter was drilled vertically through the top of the barrel of the dummy. The transducers were mounted flush with the outer wall of the cylinder and were held in place by means of the holders, see Figures 2 and 3. The two active transducers were located at 6.75 inches and 9.25 inches from the bottom of the cylinder and were 120 degree apart. It was found early in the study that an ordinary lead wire could generate a fluctuating signal due to the movement of the wire itself (see Perry[15] , p.266). So, a 4-lead shielded cable with 1/4 inch outside diameter was used. No disturbance of the signal was then found.

Cylinder assembly

An aluminum circular cylinder of 1.62 inches outside diameter was used as a model in this experiment. Figure 4 shows details of its design and installation. The upper end was fixed to the mounting bracket. The submerged part of the cylinder could be rotated about its long axis by means of a joint of 4 steel balls. For the sake of simplicity in mounting of the transducers, the cylinder was built in three parts which were connected by sleeves and pins. Finally, the surface of the cylinder was polished and coated with spray paint for protection against corrosion.

Instrumentation

The instrumentation consisted of two Vishay bridge amplifiers, one for the active and the other for the dummy, a two-channel thermal-writing Beckman recorder, and a standby oscilloscope. The utilization of the instruments has been described by Hunt[7].

A schematic diagram of the instrumentation is shown in Figure 5. The signal from the dummy transducer was subtracted from the active-transducer signal in the subtraction box. For low oscillations, the amplitude of the signal out of the subtraction box was very small. A forty-gain amplifier was built to boost the signal level for these low oscillation cases.

The signal was next passed through a ten-cycle notch filter. The notch filter was necessary to eliminate some friction noise, at approximately ten cycles,which was apparently due to the linear bearings. The filter was built especially for this purpose. The Beckman thermal-writing recorder was the next instrument in the sequence. The recorder has a sensitivity selector which can be used to adjust the gain of the filter output.

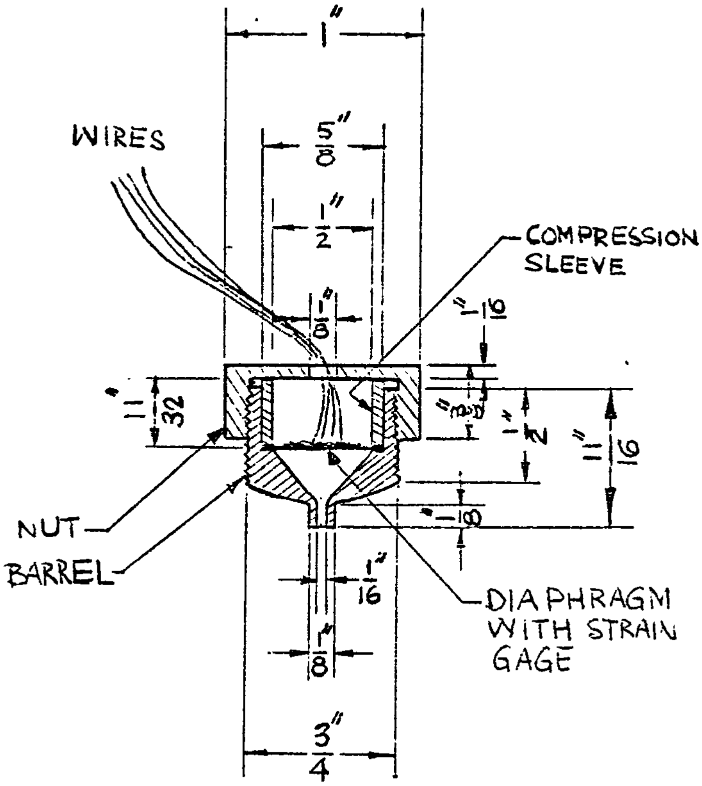


FIGURE 1. CROSS SECTION OF THE PRESSURE TRANSDUCER

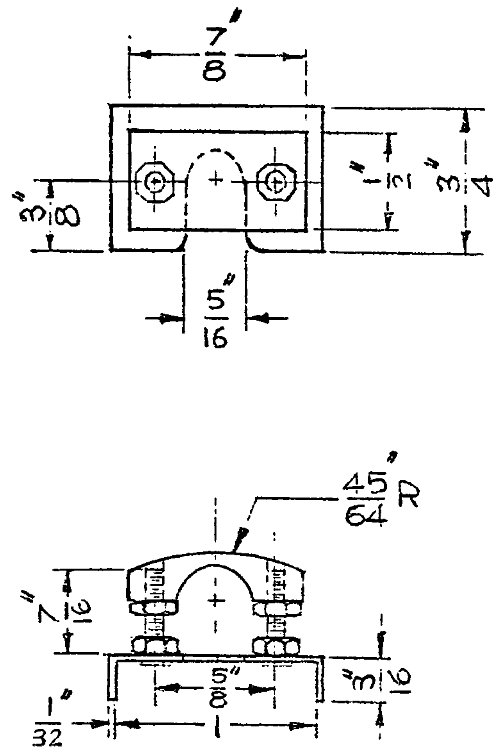


FIGURE 2. HOLDER

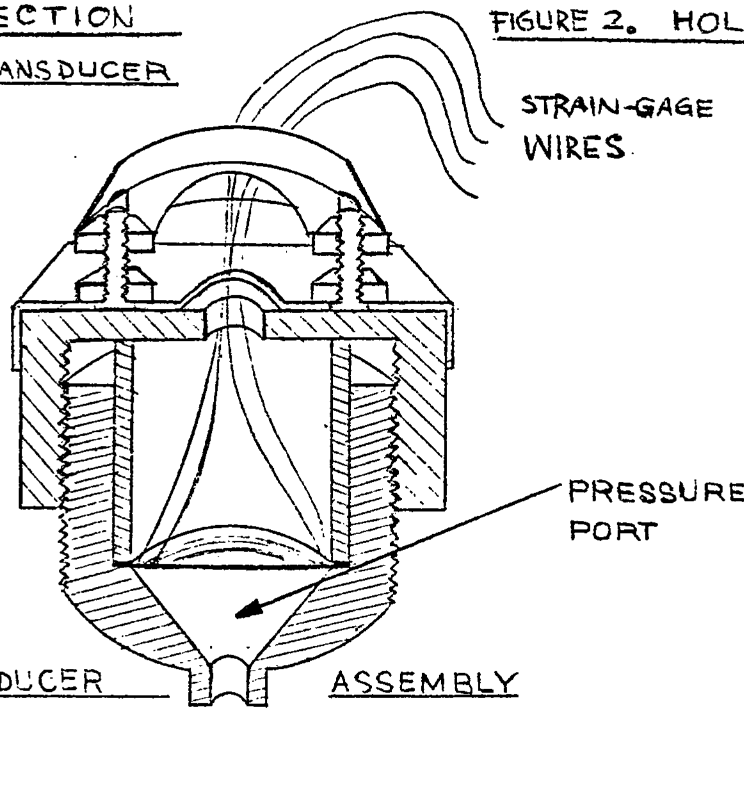


FIGURE 3. TRANSDUCER ASSEMBLY

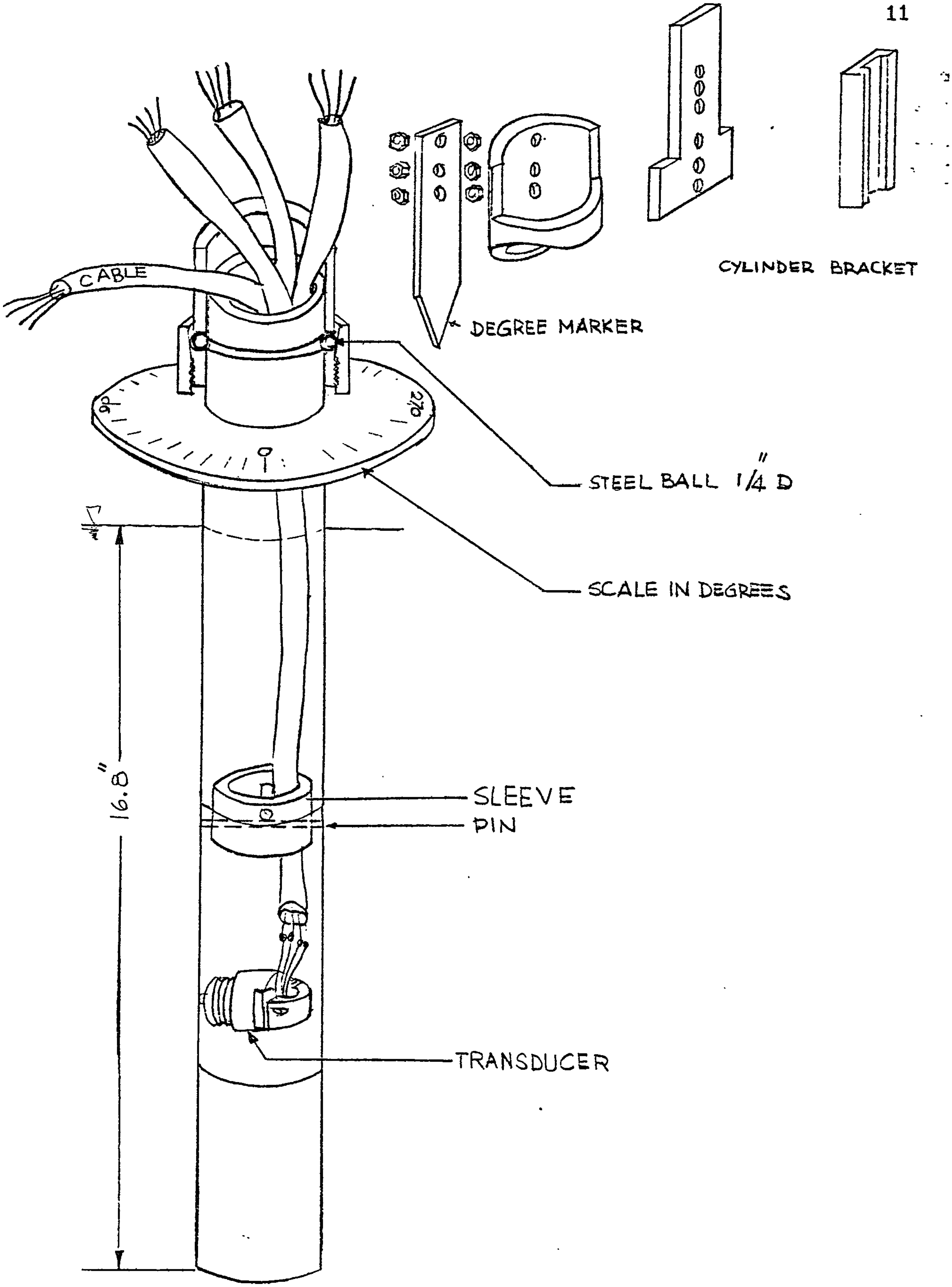


FIGURE 4. CYLINDER ASSEMBLY SHOW PARTIAL COMPONENT

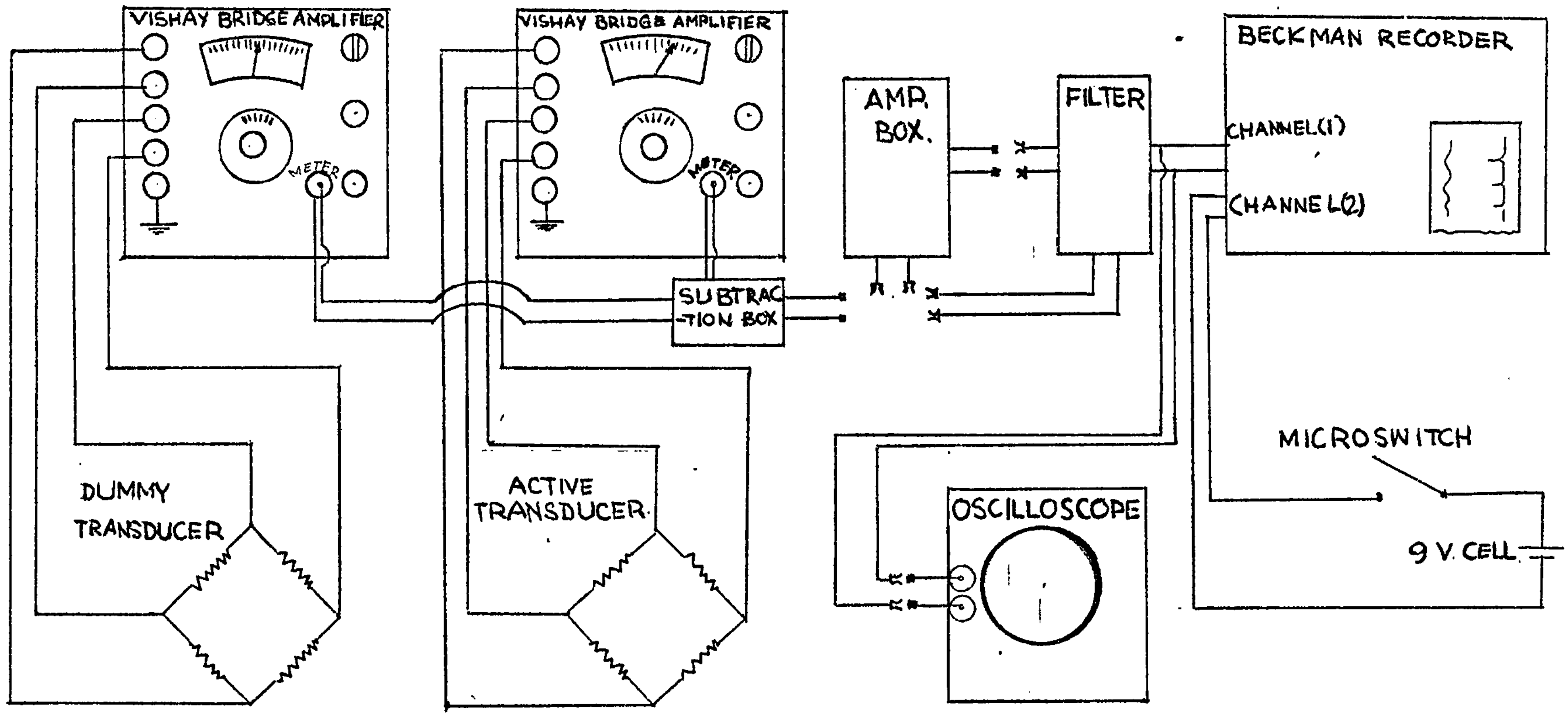


FIGURE 5 INSTRUMENTATION BLOCK DIAGRAM

CHAPTER III

CALIBRATION AND DATA PROCEDURE

Calibration

A micromanometer model 34FB2TM from Meriam Instruments was used for calibration of the transducers. This is a standard manometer with high sensitivity pressure ranging from 0.001 inch up to 10.000 inch water pressure. Thus, a precise characteristic curve for each transducer could be obtained.

Since the flexibilities of two strain gage diaphragms in each pair are not the same, it is likely that an amplifier should have been put into the circuit separately, in order to raise the lower output signals of the transducer before passing the signal through a subtraction box. Rather than do this it was decided to insert a variable resistor in parallel between the output wires of a higher-output transducer. Thus, by proper adjustment of the resistor, the original characteristic curve could be made to be the same as the lower one. It was found earlier that, in the two pairs, higher output signals were given by the active of the first one and the dummy of the second. Thus, a resistor was put into the circuit of each transducer.

Before calibration was done, the instruments had to warm up for about thirty minutes, and during this time, pressures were applied on the transducer in order to make sure that the diaphragm was stable and experiencing maximum flexibility to positive and negative pressures.

Several calibrations of each transducer were done in order to obtain a precise mean characteristic curve covering the range of zero to 10.000 inches of water pressure.

For simplicity, the first pair and the second pair of the transducers will be called X and Y respectively. The relation of water pressures (inch) and output signals (mv) for X and Y are shown in Figures 6 and 7 respectively. It is evident that both curves are linear, which means that, within a small range of pressure change, the pressure transducers are stable and have constant elasticity as anticipated. The calibration equations relating the pressure and output signal are given below:

$$X: \quad \Delta p = 0.018(mv) \quad psi., \qquad (6)$$

$$Y: \quad \Delta p = 0.023(mv) \quad psi., \qquad (7)$$

Mounting of the transducers in the cylinder

Difficulty arose in mounting the transducer inside the cylinder because of the small space limit of the test model. Epoxy and silicone rubber were applied to the outer surface of the pressure port entrances. This guarded against leakage of water into the cylinder which would destroy the wiring and moisture proofing material.

Data procedure

Arrangement of the equipment was set up as shown in Figure 5. Several test runs were performed in order to check the system and warm up the instrument for about thirty minutes. A lead wire was connected between the cylinder and ground of the Vishay amplifier because spurious noises were indicated by the stand-by oscilloscope and on the recording paper.

Prior to the test run, a table for positioning the appropriate rheostat for each corresponding speed and amplitude was determined through the paper speed of the recorder. Table 1 was used as a guide for sequential runs of the experiment. Four different periods of the displacement were generated for each of the four amplitudes; 1, 2, 4, and 6 inches respectively. The notation A, B, C, ..., N, O, P are provided for simplicity in naming the period at each amplitude. At each test, pressures around the cylinder from 0 to 360 degrees were recorded on the Beckman recorder.

For the first test at M, the active "Y" was broken, so the recordings were from the "X" alone. Several runs had been performed until the active "X" was shorted. Thus the active "Y" was repaired and able to be used again.

Amplitude inch	Period T, sec.	Speed, W		Max. acceleration inch/(sec)^2	Position of Rheostate %	Transducer	Gain
		RPM	Rad/sec.				
1, A	1.027	58.4	6.115	37.4	83.0	X	40
B	1.361	44.1	4.615	21.3	64.0	X	40
C	1.921	31.24	3.27	10.7	48.5	X	40
D	2.375	25.26	2.645	7.0	41.4	X	40
2, E	1.024	58 6	6.13	75.2	83.7	X	20
F	1.379	43.5	4.55	41.5	65.2	X	20
G	2.716	22.1	2.31	10.7	37.6	X	40
H	3.358	17.8	1.87	7.0	31.5	X	40
4, I	1.034	58.0	6.07	147.4	85.0	X	4
J	1.438	41.7	4.36	76.3	66.5	X	8
K	3.006	20.0	2.09	17.5	34.0	Y	40
L	3.841	15.6	1.63	10.7	27.5	Y	40
6, M	1.071	56.0	5.86	206.2	85.4	X	1
N	1.519	39.5	4.13	102.6	65.0	X	1
O	3.059	19.6	2.05	25.3	35.0	Y	20
P	6.083	9.8	1.03	6.4	20.5	Y	40

Table 1 - Frequency Range and Position of Rheostat at Corresponding Amplitude and Output Gain.

FIGURE 6

CHARACTERISTIC CURVE OF X

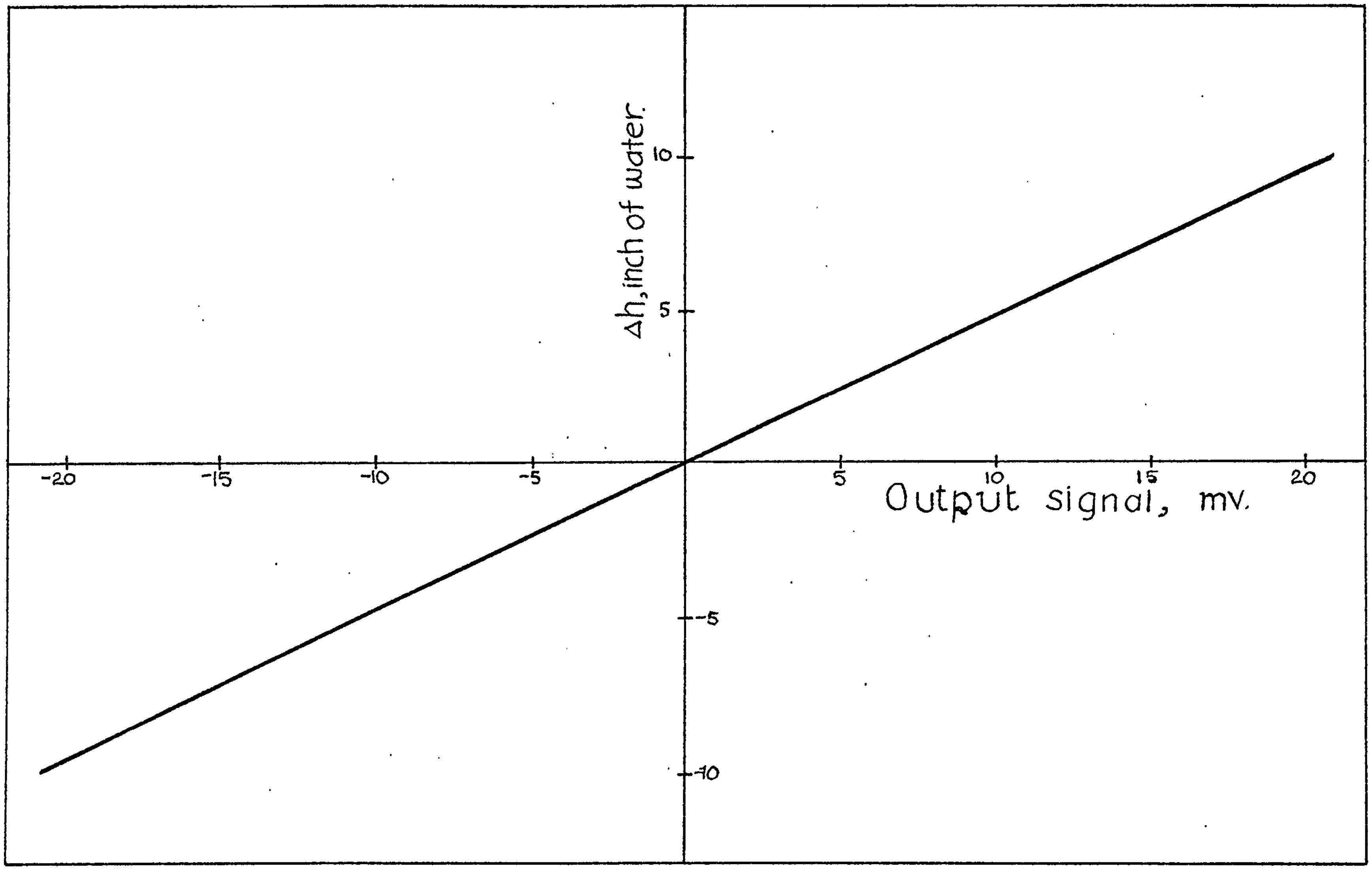
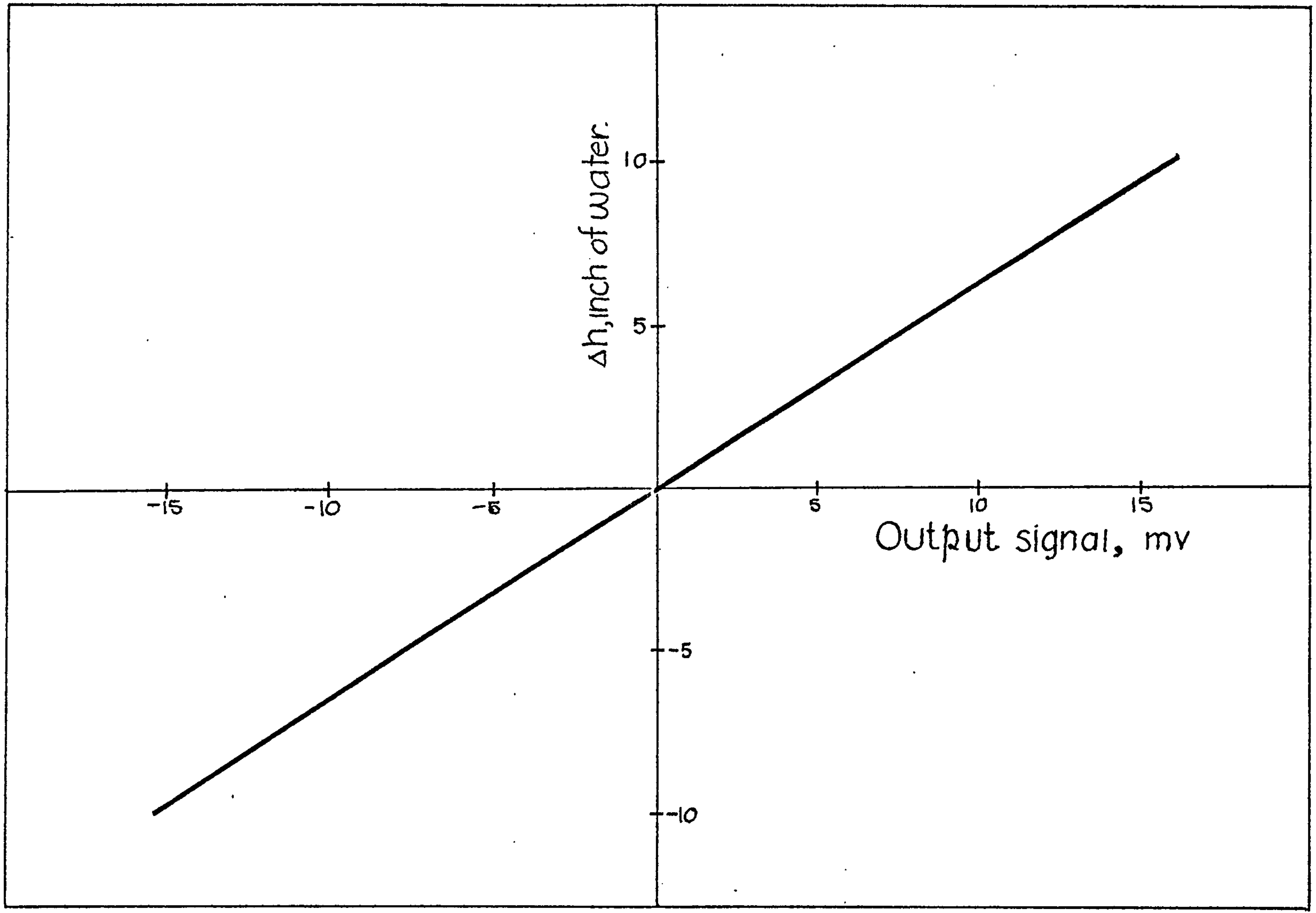


FIGURE 7

CHARACTERISTIC CURVE OF Y



CHAPTER IV

RESULTS AND EVALUATION

Four sets of tests were made in measuring the circumferential pressure distributions. Each set consisted of varying the oscillatory frequency through four values while holding the oscillation amplitude constant. The measured pressure distributions were converted to pressure coefficients with the reference velocity being the maximum oscillatory velocity. The discussion of results will be based on comparisons among the four sets of tests.

Each pressure-coefficient figure contains data representing four different positions in the oscillatory cycle: one at zero velocity, one at maximum velocity and two at half of the maximum velocity. The first at Umax/2 was for accelerating flow, the second was for decelerating flow.

The results might be anticipated to yield a maximum force at maximum velocity and a minimum force at zero velocity. The force at zero velocity would not be zero due to inertia effects. The accelerating and decelerating cases should also produce different forces even though they are at the same velocity. The accelerating cylinder should produce a larger force than the decelerating case because of the effects of positive acceleration.

Figures 8 (A) through 11 (D) represent the one-inch amplitude cases. Table 1 indicates the frequency range for this set of runs. The variation in pressure coefficient is wider for the higher frequency cases.

The maximum velocity curves have essentially the same shape in each case as for steady flow. Comparison of Figures 8 (A) and 11 (D) show that, as the period increases, the wake portion of the C_p curve increases in value (it does not have as large a negative value). The observation is the same for each of the C_p curves on a given figure as the period increases (i.e., as the velocity goes down).

Figures 12 (E) through 15 (H) show the pressure coefficient variations for the two-inch amplitude cases. The variation for these cases are much like those for the one-inch cases; the same trends are present.

Figures 16 (I) through 19 (L) depict the situation for the four-inch amplitude cases. Figures 20 (M) through 23 (P) represent the six-inch amplitude cases. Both of these sets of figures follow the same trend as that discussed for the one-inch amplitude cases. Comparison of the data can also be made by looking at different amplitudes for essentially the same period. Figures 8 (A), 12 (E), 16 (I), and 20 (M) have approximately the same period with the amplitude ranging from one inch to six inches. The wake portion of the C_p curve becomes more negative as the amplitude increases.

Figures 18 (K) and 22 (O) offer a comparison at a period of just over three seconds at amplitudes of four and six inches respectively. Again, it is noted that the wake portion of the C_p curve becomes more negative as the amplitude increases at essentially the same period.

The force-per-unit-length can be determined from the pressure-coefficient curves by means of

$$F/L = \rho a V_{max}^2 \int_0^{\pi} C_p \cos\theta \, d\theta$$

The integration was accomplished numerically by means of Weddle's rule[16].

The force-per-unit-length results are shown in Table 2. In each case the instantaneous force follows what was anticipated. Cases 8 (A) through 11 (D) show that the instantaneous force decreases as the period increases at one inch of amplitude. This same trend is true for each different amplitude set. As the amplitude increased for a given period (i,e., as the velocity increasesed) the instantaneous force-per-unit-length also increased as expected.

Dimensionless forces, defined by

$$\mathbb{F} = \frac{F/L}{\rho V_{max}^2 d/2} ,$$

are shown in table 3. In each case the force coefficients are larger for the smaller periods. The trend is what would be expected from comparison to the steady flow values at the same Reynolds numbers.

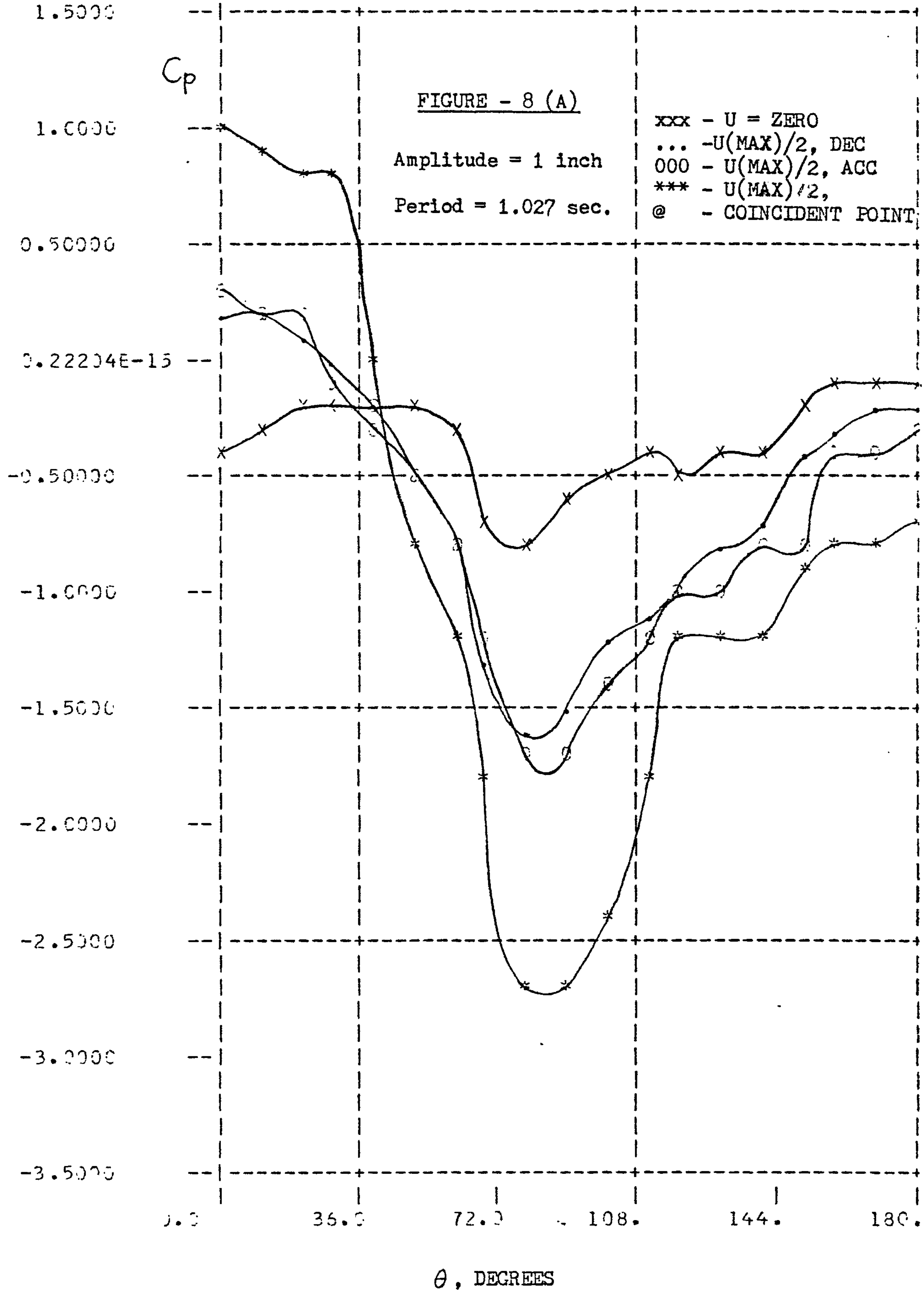


FIGURE - 8 (A)
Amplitude = 1 inch
Period = 1.027 sec.
xxx - U = ZERO
... -U(MAX)/2, DEC
000 - U(MAX)/2, ACC
*** - U(MAX)/2,
@ - COINCIDENT POINT
Cp
1.5000
1.0000
0.50000
0.22204E-15
-0.50000
-1.0000
-1.5000
-2.0000
-2.5000
-3.0000
-3.5000
0.0
36.0
72.0
108.
144.
180.
θ, DEGREES

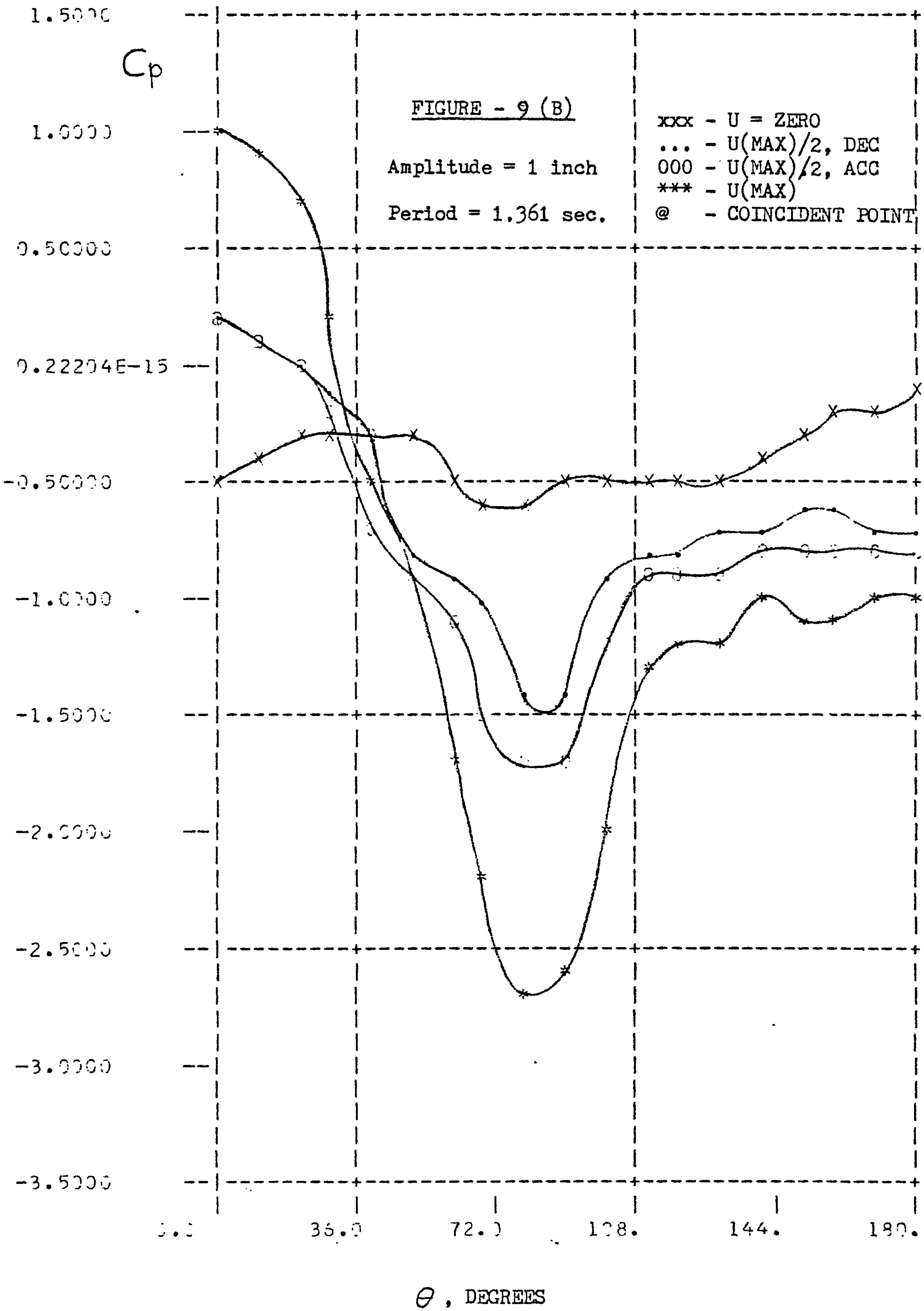
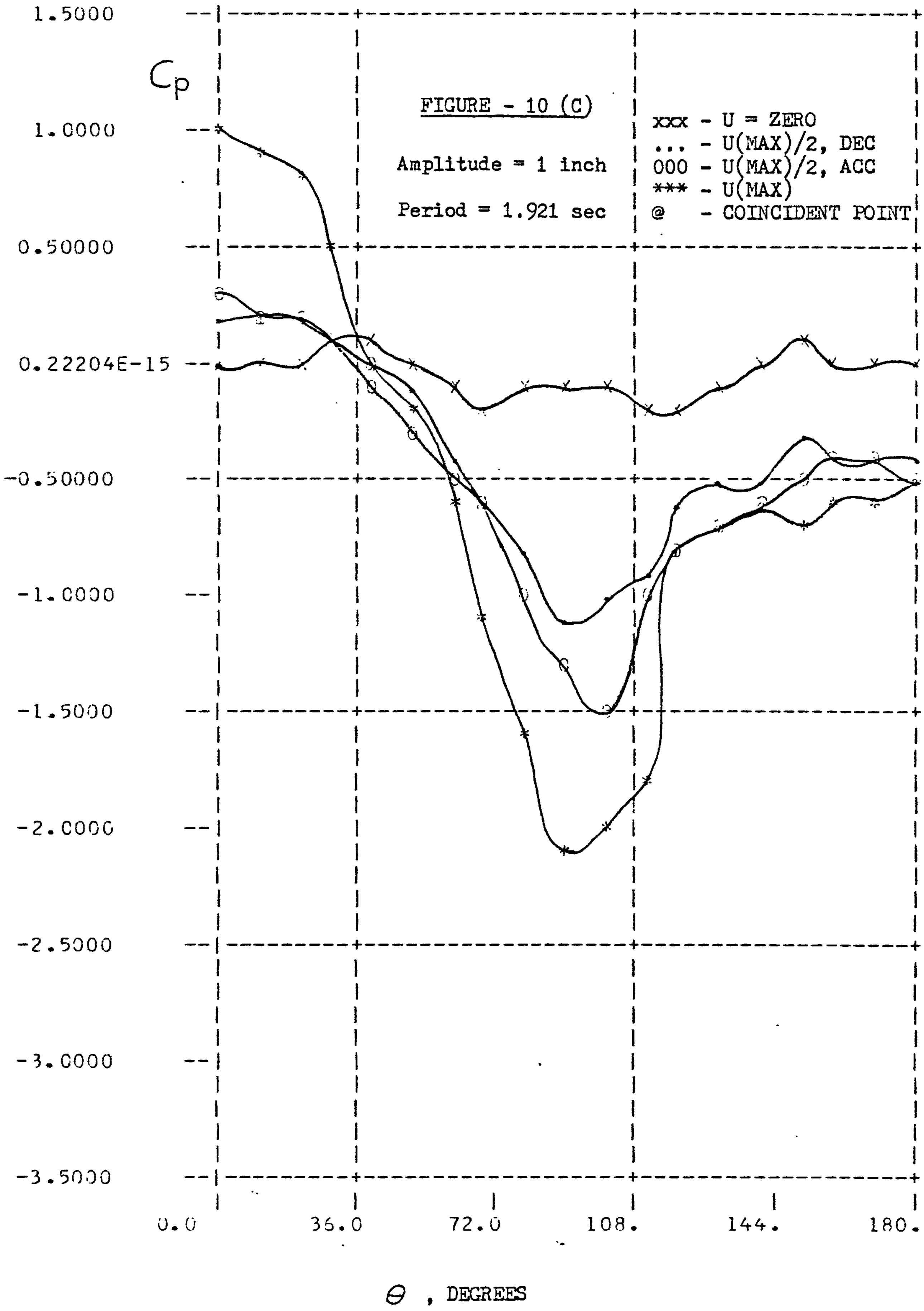


FIGURE - 9 (B)
Amplitude = 1 inch
Period = 1.361 sec.
xxx - U = ZERO
... - U(MAX)/2, DEC
000 - U(MAX)/2, ACC
*** - U(MAX)
@ - COINCIDENT POINT
Cp
1.5000
1.0000
0.50000
0.22204E-15
-0.50000
-1.0000
-1.5000
-2.0000
-2.5000
-3.0000
-3.5000
0.0
36.0
72.0
108.
144.
180.
θ , DEGREES



Cp
FIGURE - 10 (C)
Amplitude = 1 inch
Period = 1.921 sec
xxx - U = ZERO
... - U(MAX)/2, DEC
000 - U(MAX)/2, ACC
*** - U(MAX)
@ - COINCIDENT POINT
1.5000
1.0000
0.50000
0.22204E-15
-0.50000
-1.0000
-1.5000
-2.0000
-2.5000
-3.0000
-3.5000
0.0
36.0
72.0
108.
144.
180.
θ , DEGREES

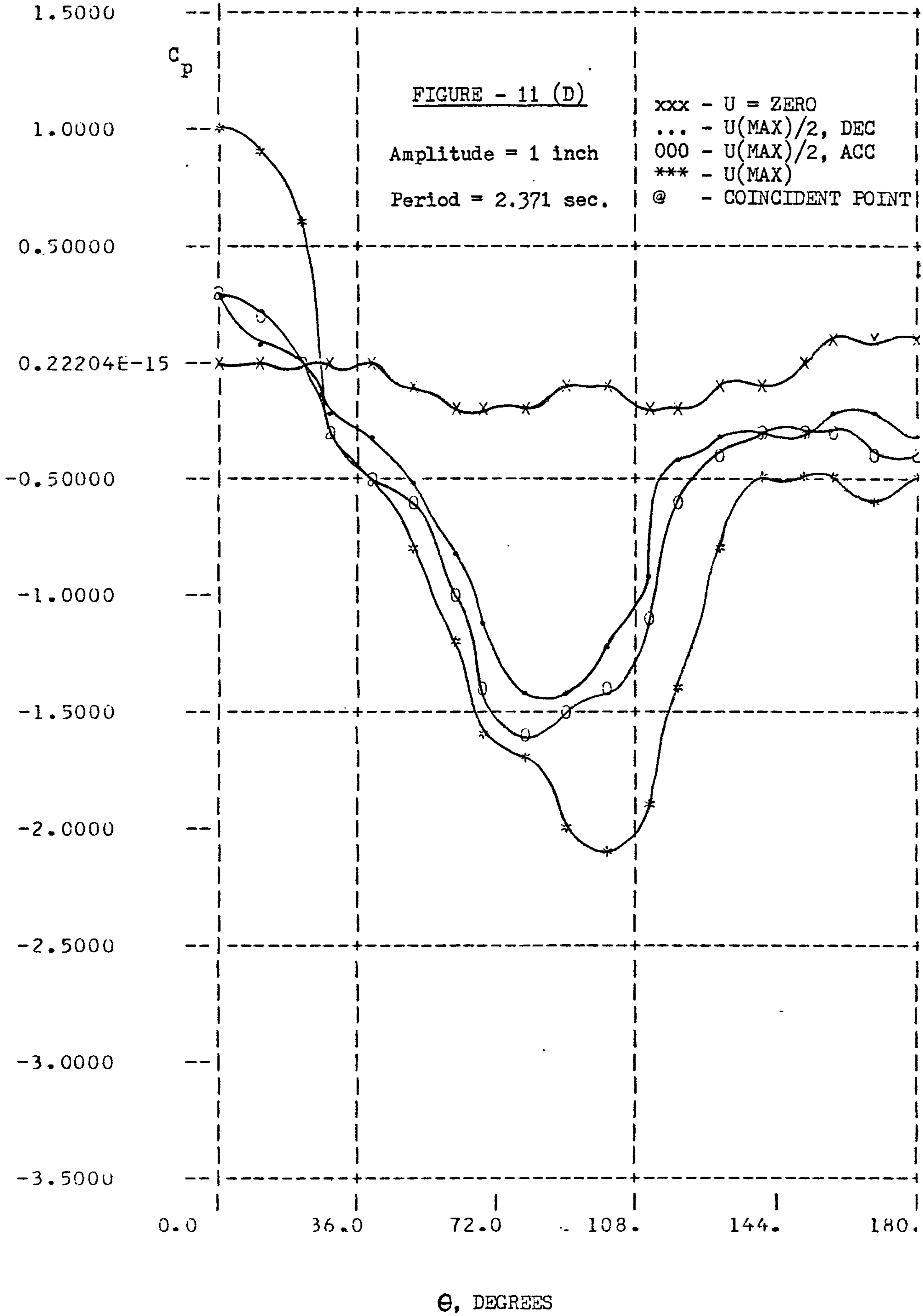
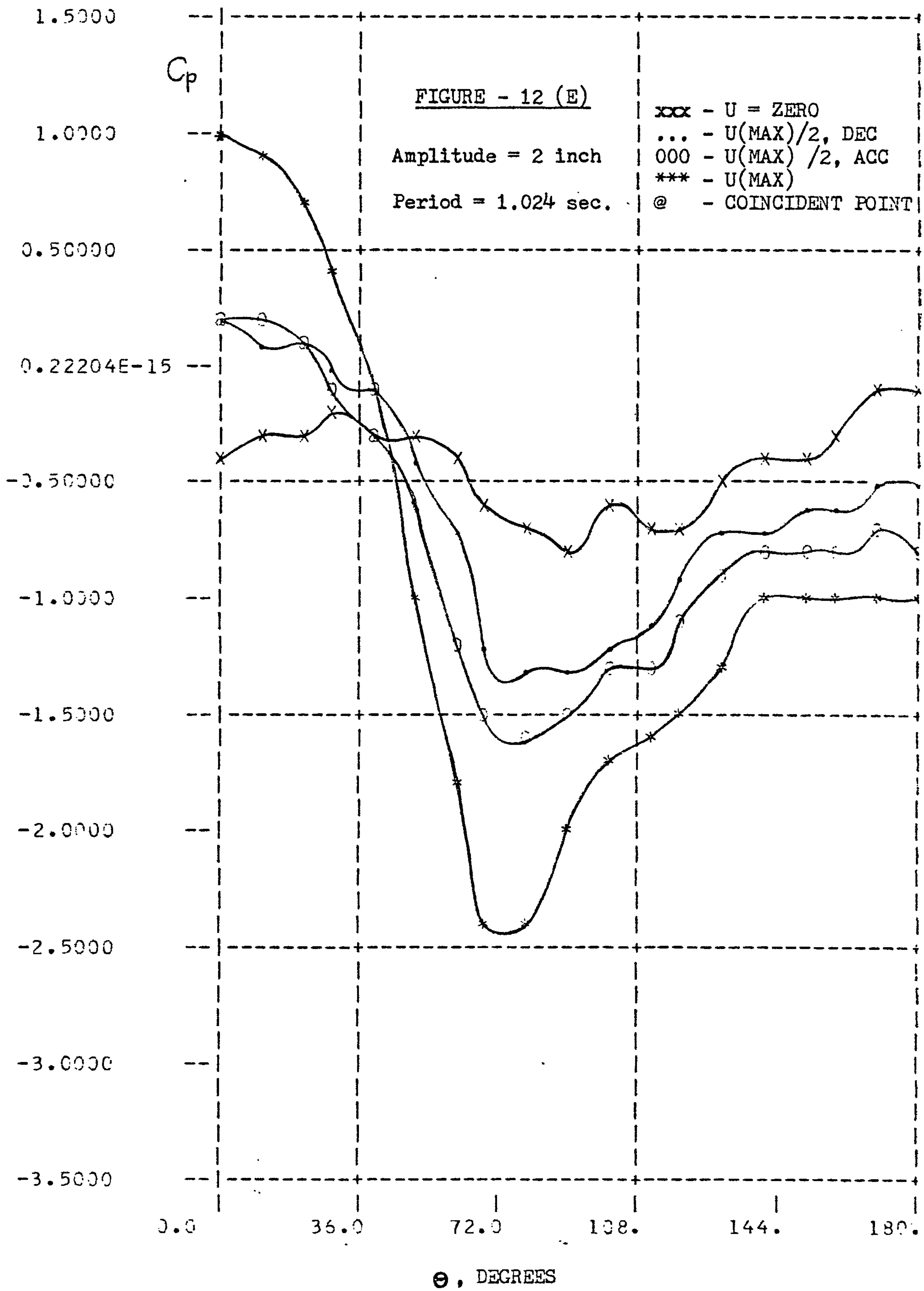
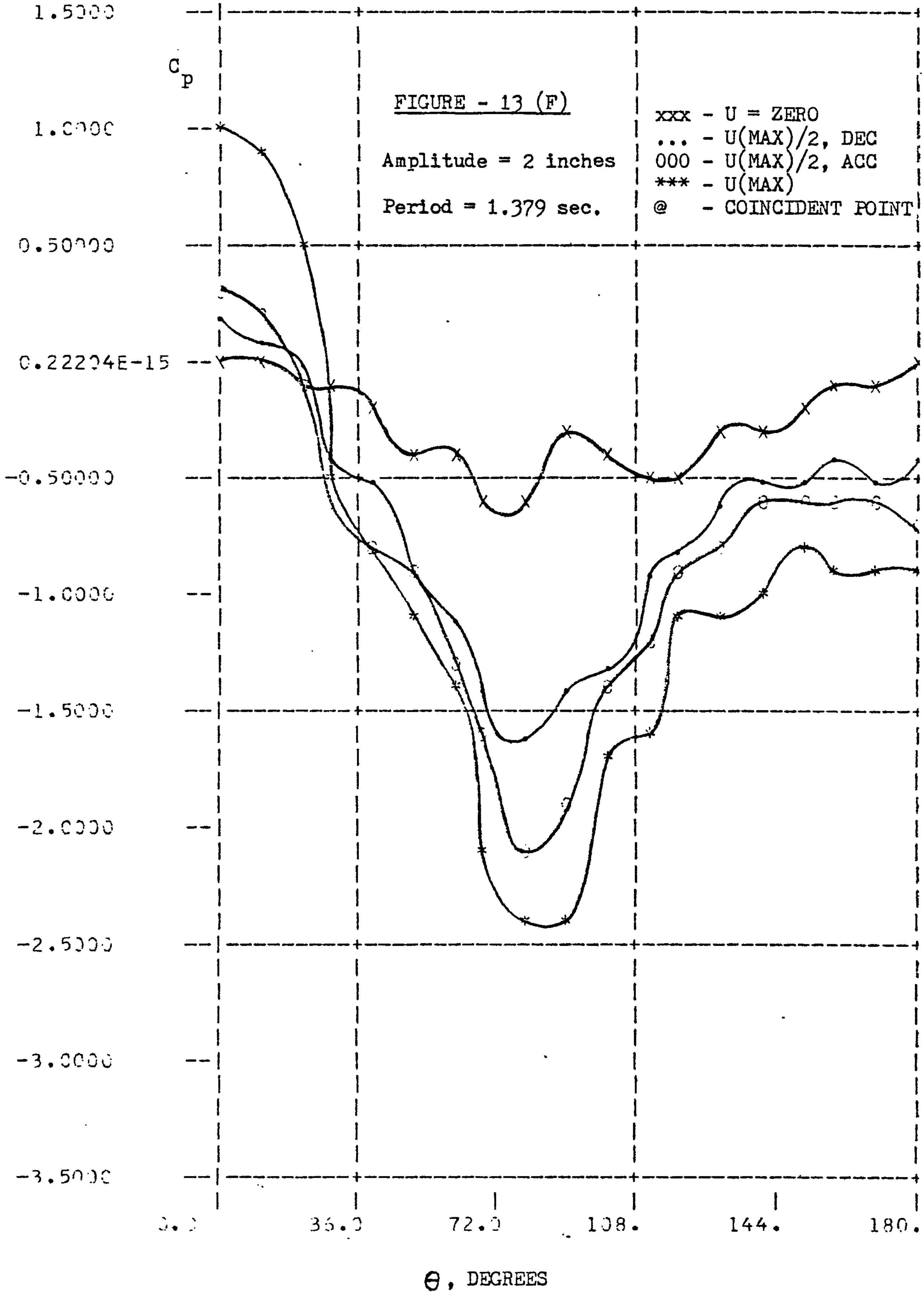


FIGURE - 11 (D)
Amplitude = 1 inch
Period = 2.371 sec.
xxx - U = ZERO
... - U(MAX)/2, DEC
000 - U(MAX)/2, ACC
*** - U(MAX)
@ - COINCIDENT POINT
C_p
1.5000
1.0000
0.50000
0.22204E-15
-0.50000
-1.0000
-1.5000
-2.0000
-2.5000
-3.0000
-3.5000
0.0
36.0
72.0
108.
144.
180.
θ, DEGREES



1.5000
1.0000
0.50000
0.22204E-15
-0.50000
-1.0000
-1.5000
-2.0000
-2.5000
-3.0000
-3.5000
C_p
FIGURE - 12 (E)
Amplitude = 2 inch
Period = 1.024 sec.
xxx - U = ZERO
... - U(MAX)/2, DEC
000 - U(MAX) /2, ACC
*** - U(MAX)
@ - COINCIDENT POINT
0.0
36.0
72.0
108.
144.
180.
Θ, DEGREES


1.5000
1.0000
0.50000
0.22204E-15
-0.50000
-1.0000
-1.5000
-2.0000
-2.5000
-3.0000
-3.5000
C_p
FIGURE - 13 (F)
Amplitude = 2 inches
Period = 1.379 sec.
xxx - U = ZERO
... - U(MAX)/2, DEC
000 - U(MAX)/2, ACC
*** - U(MAX)
@ - COINCIDENT POINT
0.0
36.0
72.0
108.
144.
180.
θ, DEGREES

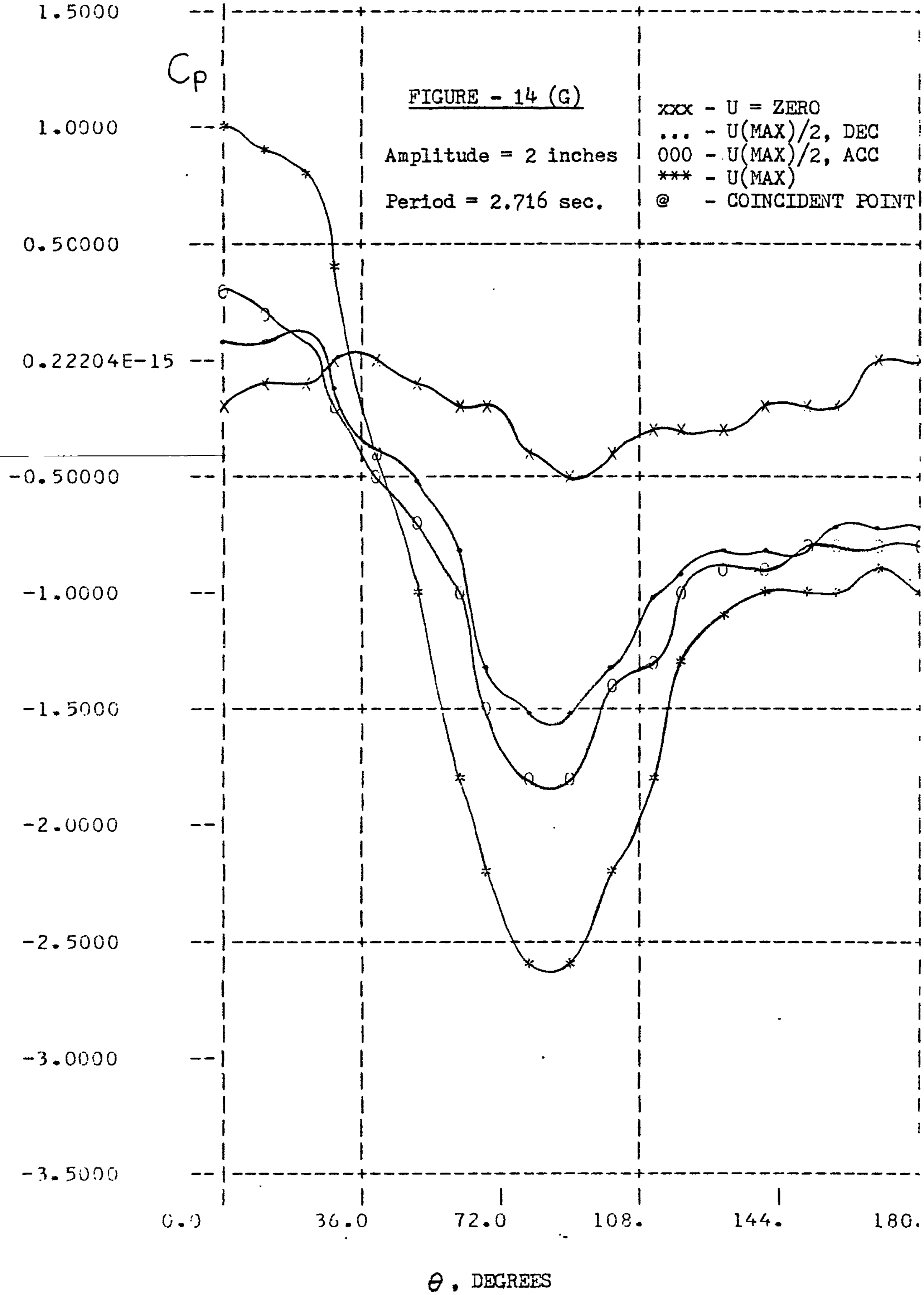
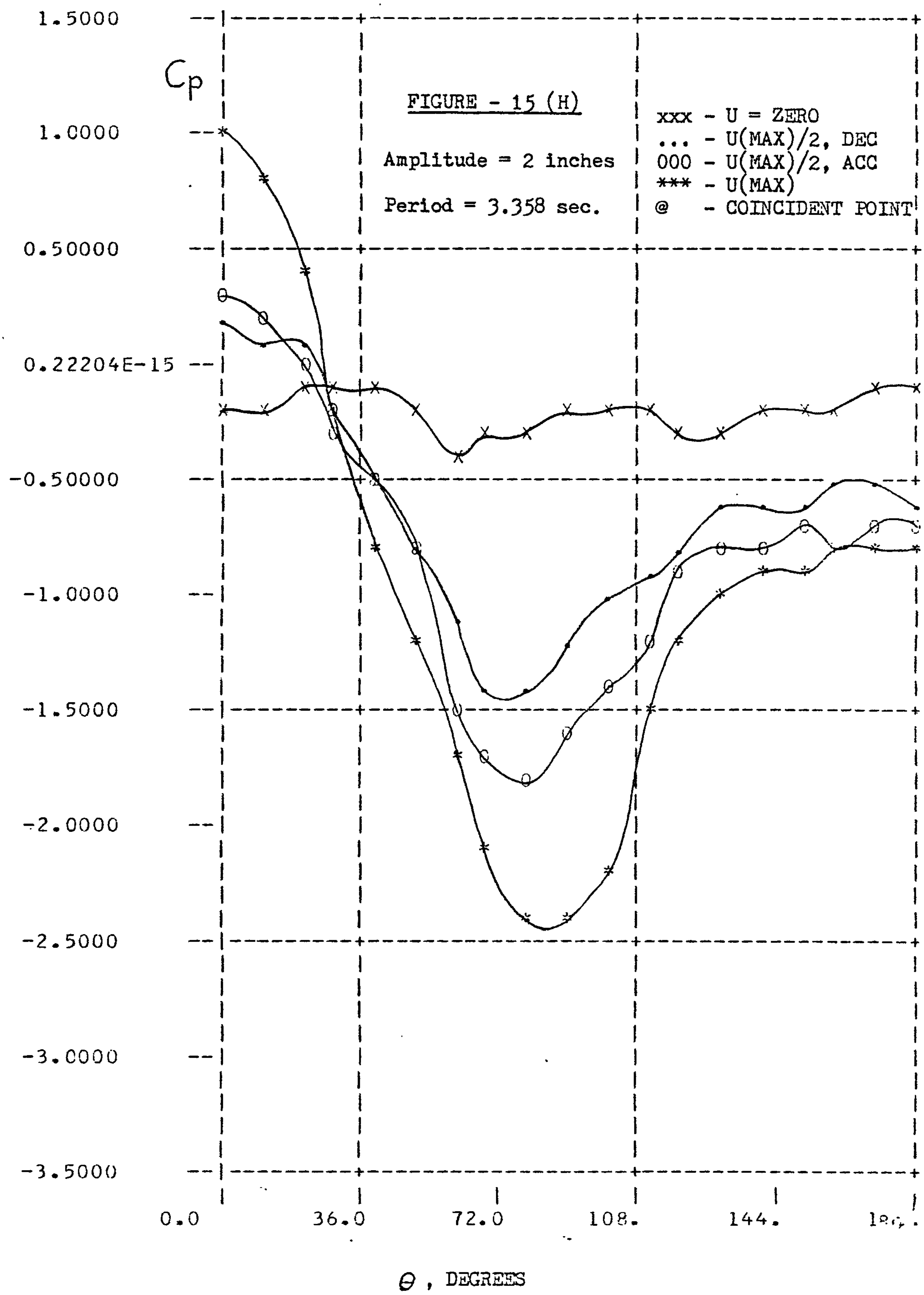


FIGURE - 14 (G)
Amplitude = 2 inches
Period = 2.716 sec.
xxx - U = ZERO
... - U(MAX)/2, DEC
000 - U(MAX)/2, ACC
*** - U(MAX)
@ - COINCIDENT POINT
Cp
1.5000
1.0000
0.50000
0.22204E-15
-0.50000
-1.0000
-1.5000
-2.0000
-2.5000
-3.0000
-3.5000
0.0
36.0
72.0
108.
144.
180.
θ, DEGREES



Cp
FIGURE - 15 (H)
Amplitude = 2 inches
Period = 3.358 sec.
xxx - U = ZERO
... - U(MAX)/2, DEC
000 - U(MAX)/2, ACC
*** - U(MAX)
@ - COINCIDENT POINT
1.5000
1.0000
0.50000
0.22204E-15
-0.50000
-1.0000
-1.5000
-2.0000
-2.5000
-3.0000
-3.5000
0.0
36.0
72.0
108.
144.
θ, DEGREES

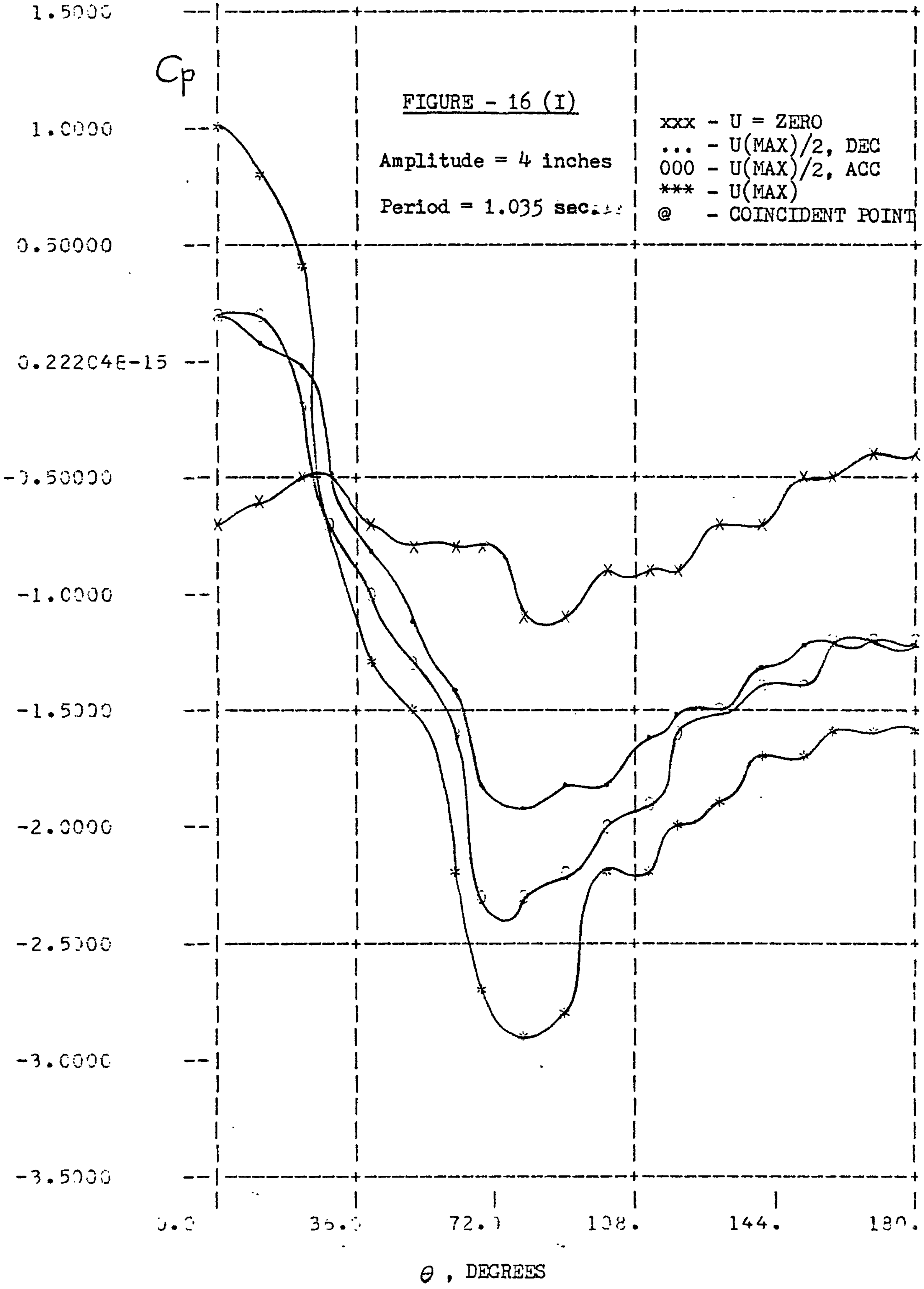
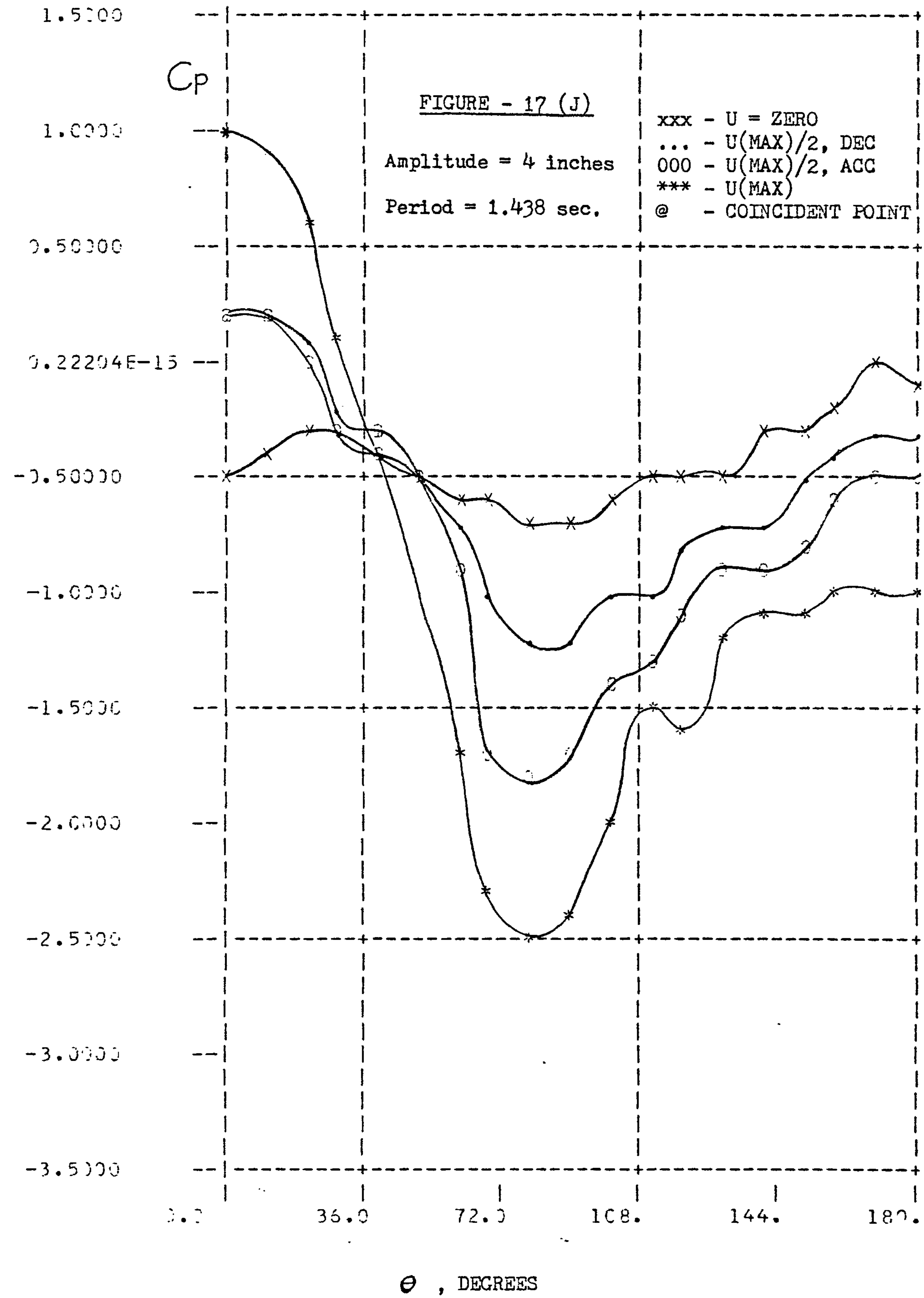
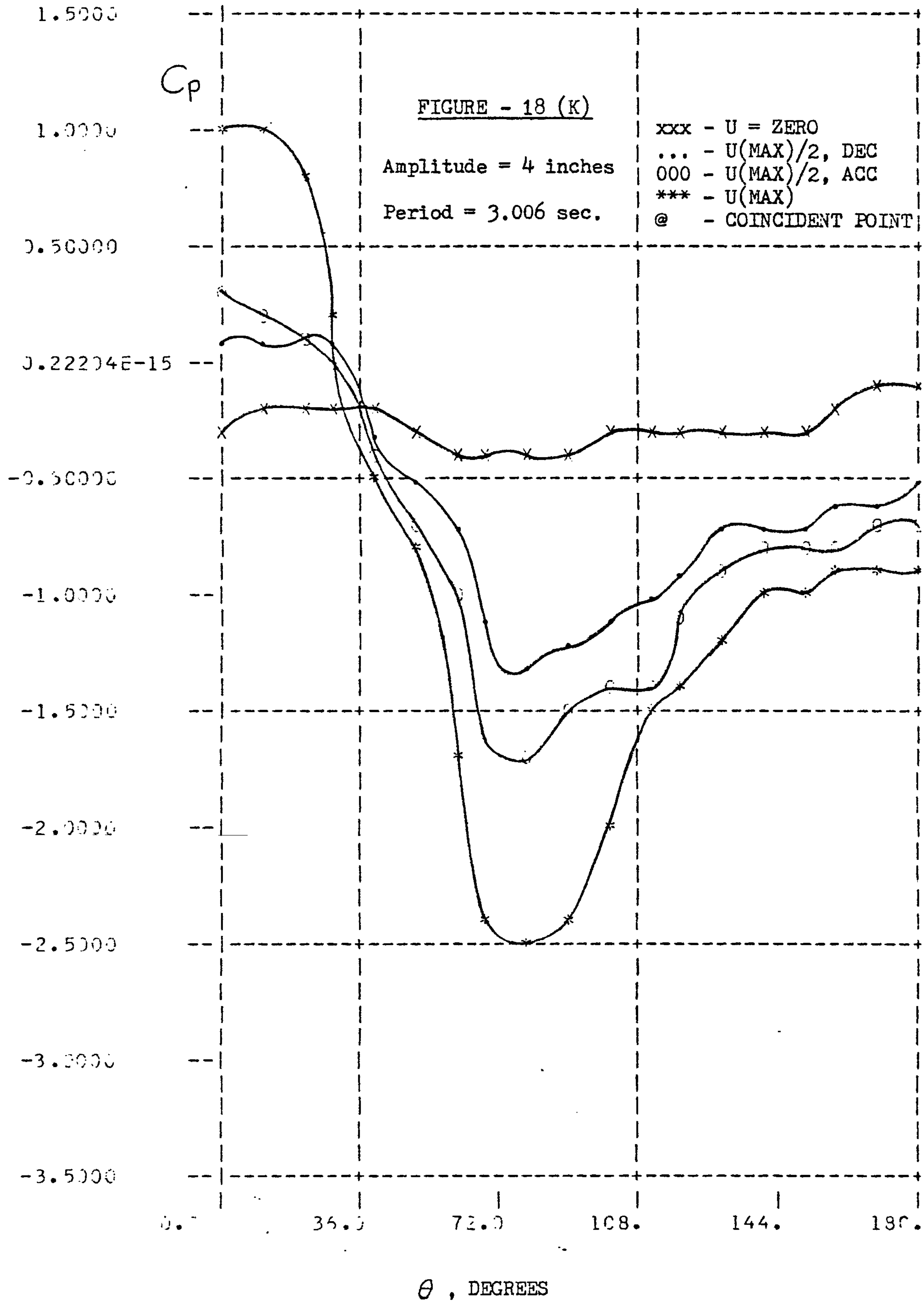


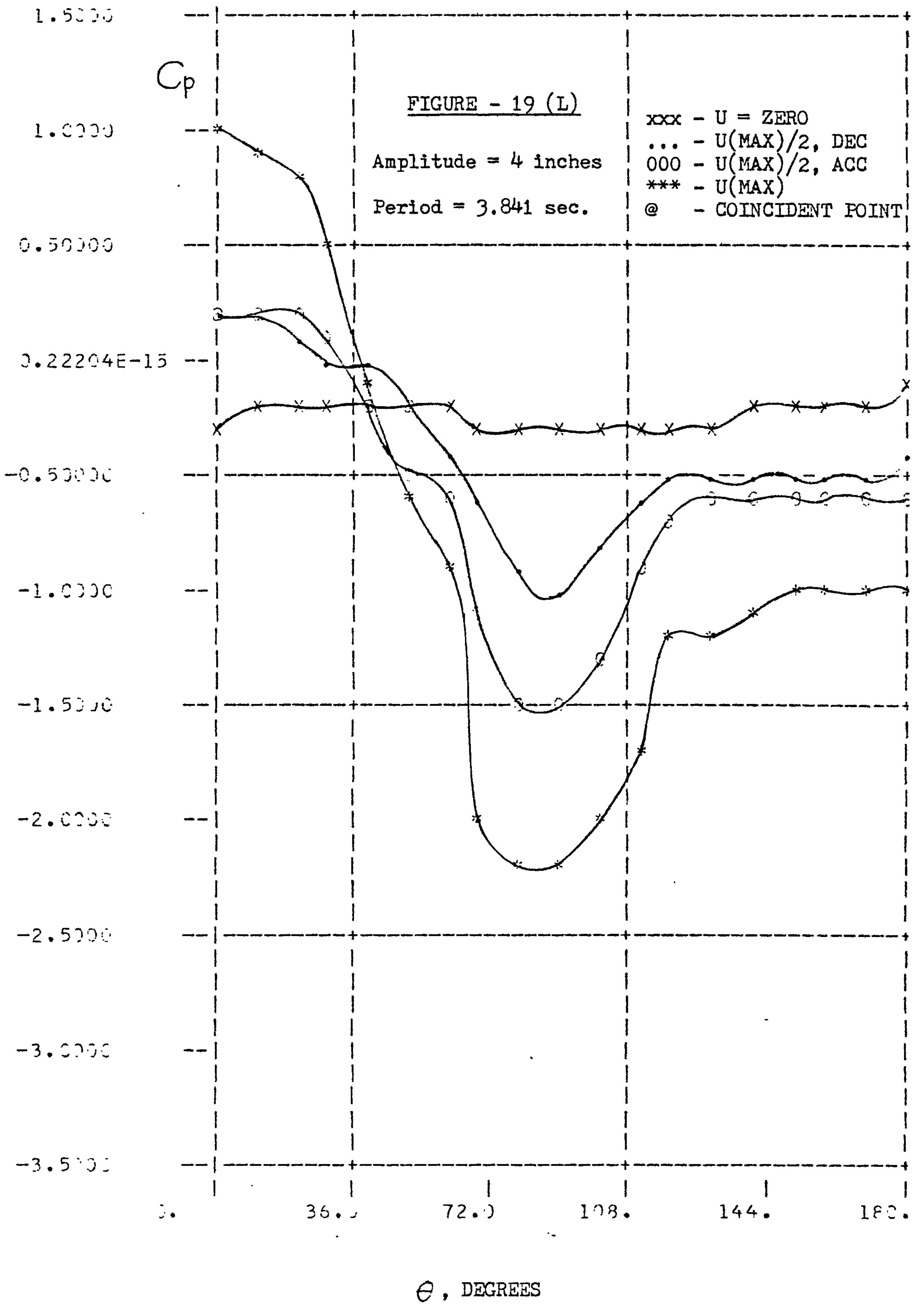
FIGURE - 16 (I)
Amplitude = 4 inches
Period = 1.035 sec.
xxx - U = ZERO
... - U(MAX)/2, DEC
000 - U(MAX)/2, ACC
*** - U(MAX)
@ - COINCIDENT POINT
Cp
1.5000
1.0000
0.50000
0.22204E-15
-0.50000
-1.0000
-1.5000
-2.0000
-2.5000
-3.0000
-3.5000
0.0
36.0
72.0
108.
144.
180.
θ , DEGREES

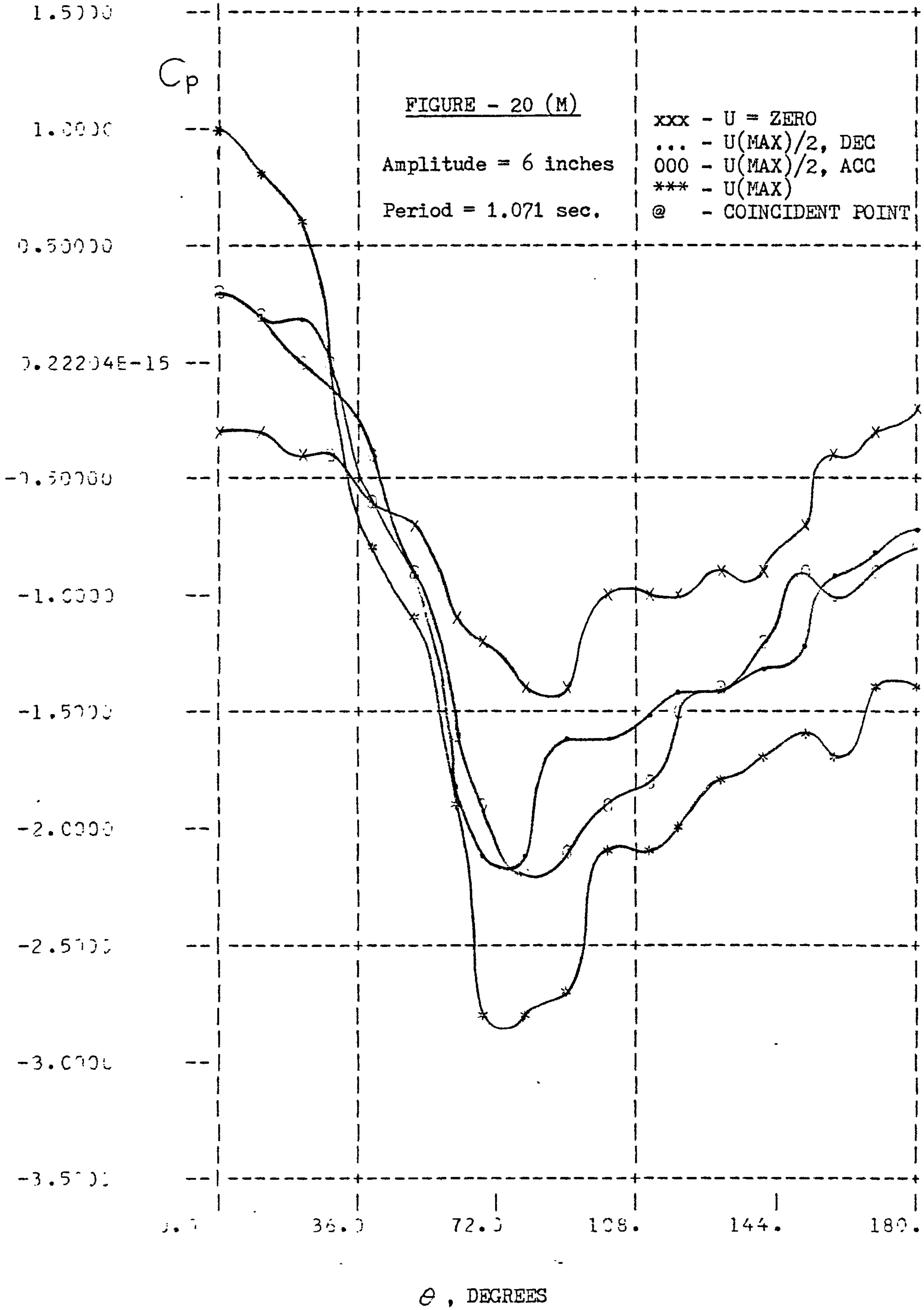


1.5000
1.0000
0.50000
0.22204E-15
-0.50000
-1.0000
-1.5000
-2.0000
-2.5000
-3.0000
-3.5000
Cp
FIGURE - 17 (J)
Amplitude = 4 inches
Period = 1.438 sec.
xxx - U = ZERO
... - U(MAX)/2, DEC
000 - U(MAX)/2, ACC
*** - U(MAX)
@ - COINCIDENT POINT
0.0
36.0
72.0
108.
144.
180.
θ , DEGREES



1.5000
1.0000
0.50000
0.22204E-15
-0.50000
-1.0000
-1.5000
-2.0000
-2.5000
-3.0000
-3.5000
Cp
FIGURE - 18 (K)
Amplitude = 4 inches
Period = 3.006 sec.
xxx - U = ZERO
... - U(MAX)/2, DEC
000 - U(MAX)/2, ACC
*** - U(MAX)
@ - COINCIDENT POINT
0.
36.0
72.0
108.
144.
180.
θ , DEGREES


Cp
FIGURE - 19 (L)
Amplitude = 4 inches
Period = 3.841 sec.
xxx - U = ZERO
... - U(MAX)/2, DEC
000 - U(MAX)/2, ACC
*** - U(MAX)
@ - COINCIDENT POINT
1.5000
1.0000
0.50000
0.22204E-15
-0.50000
-1.0000
-1.5000
-2.0000
-2.5000
-3.0000
-3.5000
0.
36.0
72.0
108.
144.
180.
θ, DEGREES


1.5000
1.0000
0.50000
0.22204E-15
-0.50000
-1.0000
-1.5000
-2.0000
-2.5000
-3.0000
-3.5000
Cp
FIGURE - 20 (M)
Amplitude = 6 inches
Period = 1.071 sec.
xxx - U = ZERO
... - U(MAX)/2, DEC
000 - U(MAX)/2, ACC
*** - U(MAX)
@ - COINCIDENT POINT
36.0
72.0
108.
144.
180.
θ , DEGREES

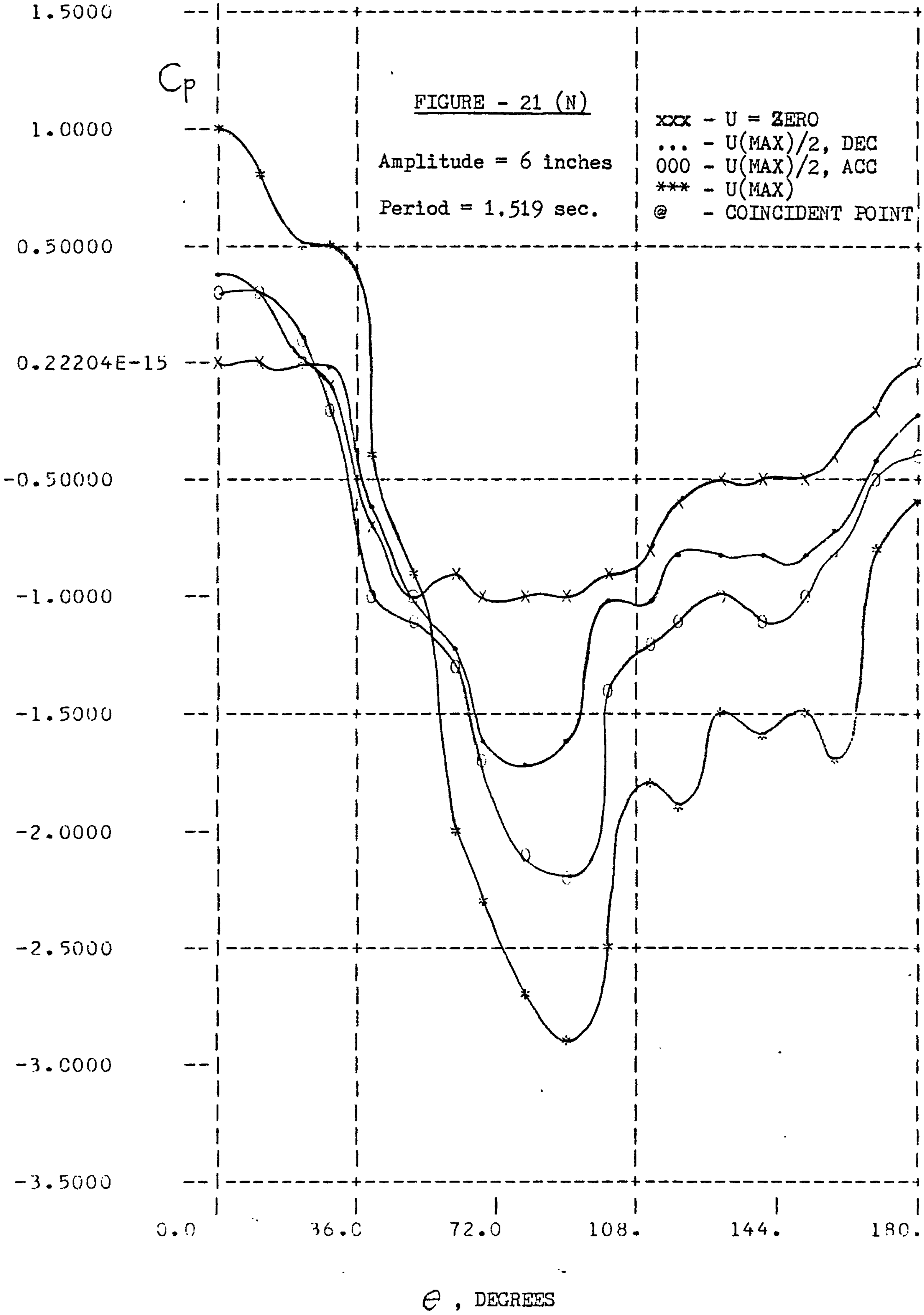


FIGURE - 21 (N)
Amplitude = 6 inches
Period = 1.519 sec.
xxx - U = ZERO
... - U(MAX)/2, DEC
000 - U(MAX)/2, ACC
*** - U(MAX)
@ - COINCIDENT POINT
Cp
1.5000
1.0000
0.50000
0.22204E-15
-0.50000
-1.0000
-1.5000
-2.0000
-2.5000
-3.0000
-3.5000
0.0
36.0
72.0
108.
144.
180.
θ, DEGREES

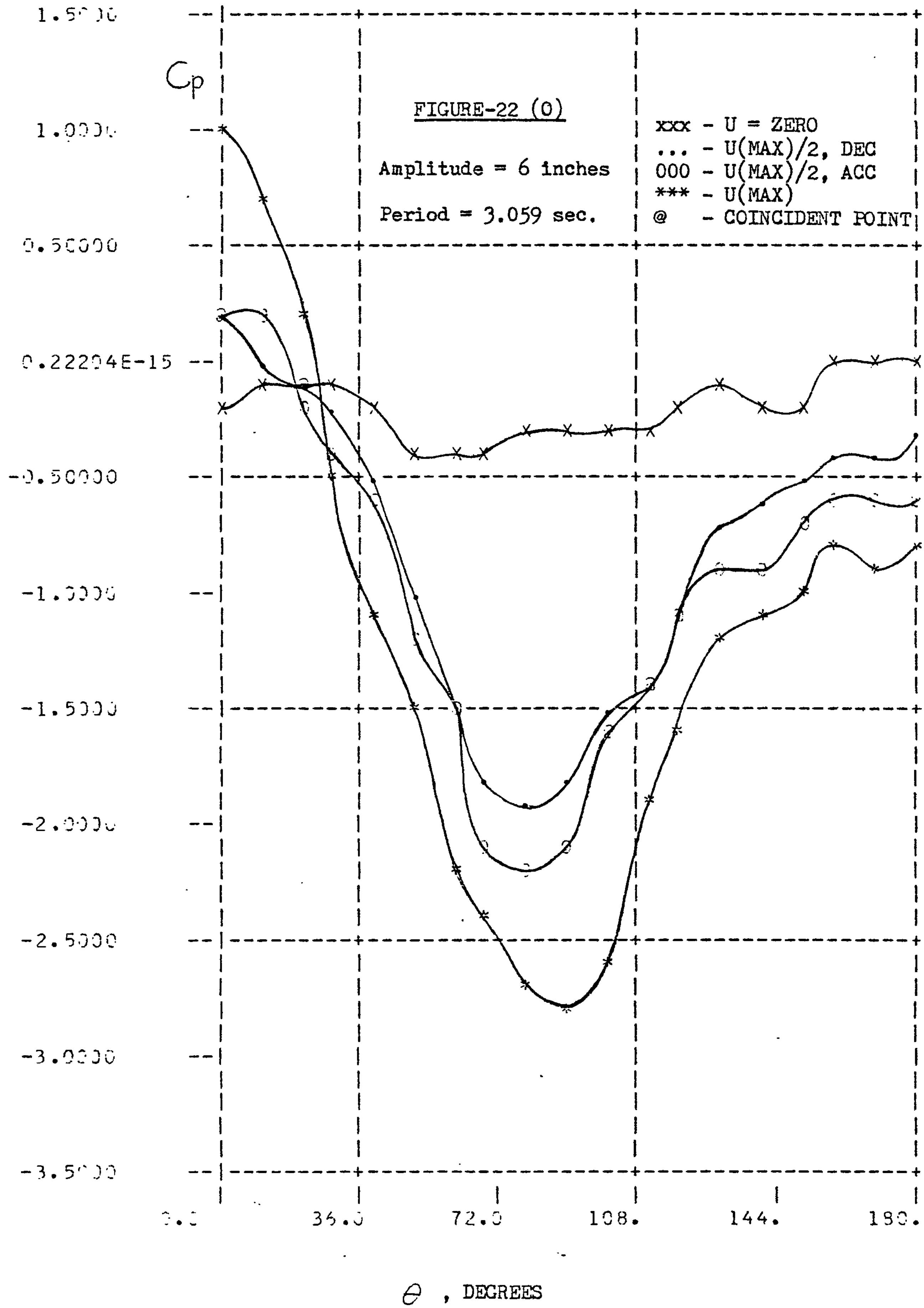


FIGURE-22 (0)
Amplitude = 6 inches
Period = 3.059 sec.
xxx - U = ZERO
... - U(MAX)/2, DEC
000 - U(MAX)/2, ACC
*** - U(MAX)
@ - COINCIDENT POINT
Cp
1.5000
1.0000
0.50000
0.22204E-15
-0.50000
-1.0000
-1.5000
-2.0000
-2.5000
-3.0000
-3.5000
0.0
36.0
72.0
108.
144.
180.
θ , DEGREES

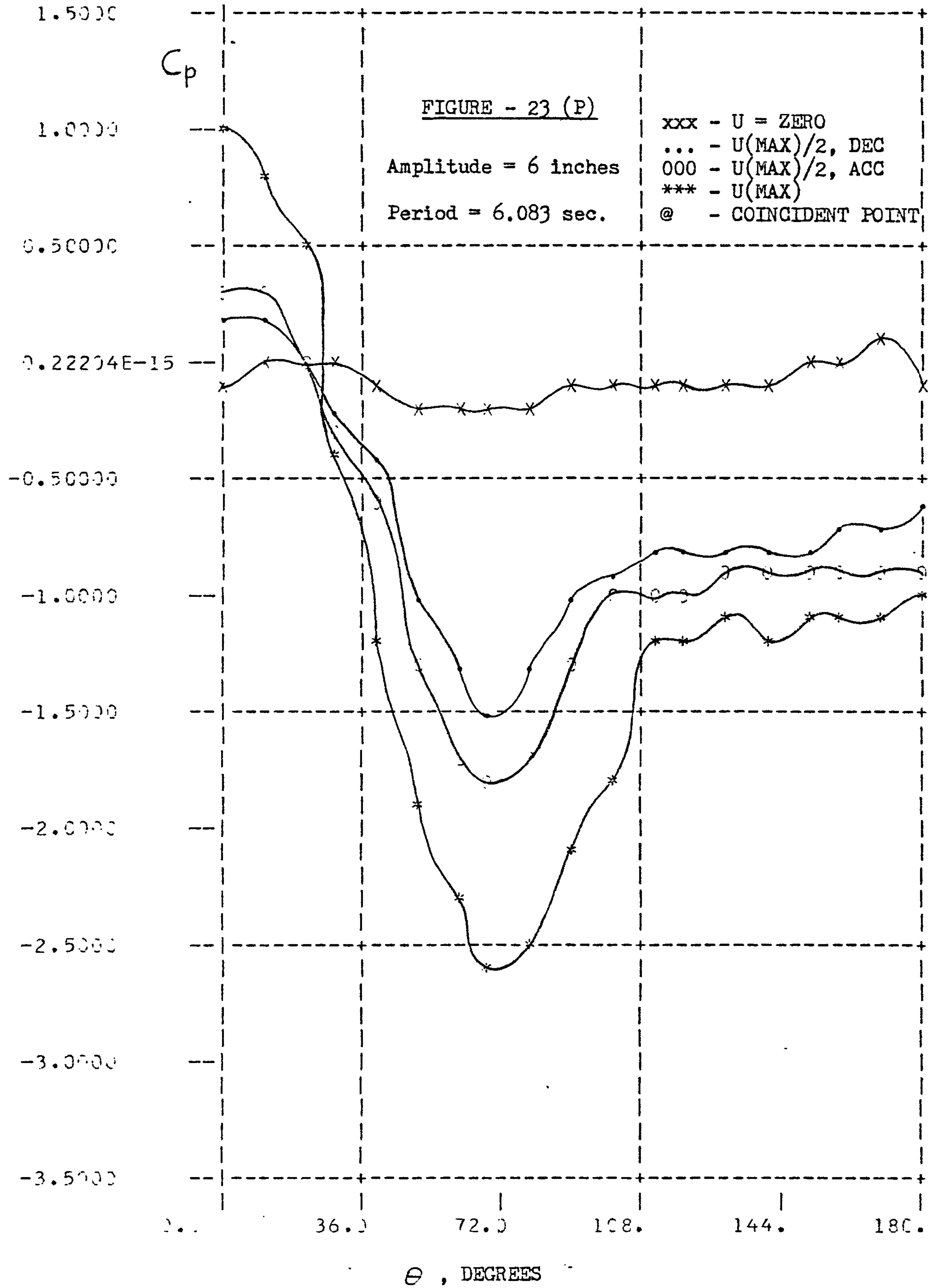


FIGURE - 23 (P)
Amplitude = 6 inches
Period = 6.083 sec.
xxx - U = ZERO
... - U(MAX)/2, DEC
000 - U(MAX)/2, ACC
*** - U(MAX)
@ - COINCIDENT POINT
Cp
1.5000
1.0000
0.50000
0.22204E-15
-0.50000
-1.0000
-1.5000
-2.0000
-2.5000
-3.0000
-3.5000
0.
36.0
72.0
108.
144.
180.
θ , DEGREES

Table 2 - Forces at Different Amplitudes and Periods

Amplitude	Force-per-unit-length of cylinder			
	U(MAX)	U(MAX)/2,ACC	U(MAX)/2,DEC	U= ZERO
1, A	0.0034	0.0015	0.0009	-0.0001
B	0.0016	0.0007	0.0006	-0.0001
C	0.0008	0.0005	0.0004	-0.0000
D	0.0003	0.0001	0.0000	0.0000
2, E	0.0120	0.0060	0.0054	0.0002
F	0.0040	0.0012	0.0007	0.0002
G	0.0016	0.0009	0.0008	0.0001
H	0.0007	0.0004	0.0003	-0.0000
4, I	0.0522	0.0331	0.0307	-0.0019
J	0.0248	0.0104	0.0074	-0.0035
K	0.0065	0.0026	0.0023	0.0001
L	0.0032	0.0019	0.0016	-0.0000
6, M	0.1232	0.0692	0.0598	0.0093
N	0.0591	0.0188	0.0172	0.0026
O	0.0063	0.0025	0.0013	-0.0008
P	0.0016	0.0012	0.0010	-0.0001

Table 3 - Dimensionless Forces at Differents

Amplitude and Periods

Ampli-	Dimensionless Force / Reynolds number			
tude	U(MAX)	U(MAX)/2,ACC	U(MAX)/2, DCC	U = ZERO
1, A	$1.195/5.65X10^3$	$0.523/2.82X10^3$	$0.332/2.82X10^3$	-0.031
B	$0.966/4.26X10^3$	$0.441/2.13X10^3$	$0.399/2.13X10^3$	-0.046
C	$1.040/3.02X10^3$	$0.566/1.51X10^3$	$0.469/1.51X10^3$	-0.039
D	$0.640/2.42X10^3$	$0.110/1.33X10^3$	$0.072/1.33X10^3$	-0.98
2, E	$1.057/1.13X10^4$	$0.582/5.67X10^3$	$0.472/5.67X10^3$	0.017
F	$0.644/8.41X10^3$	$0.187/4.21X10^3$	$0.104/4.21X10^3$	0.033
G	$1.010/4.27X10^3$	$0.553/2.14X10^3$	$0.514/2.14X10^3$	0.068
H	$0.641/3.46X10^3$	$0.368/1.73X10^3$	$0.265/1.73X10^3$	-0.005
4, I	$1.168/2.24X10^4$	$0.687/1.12X10^4$	$0.741/1.12X10^4$	-0.042
J	$1.074/1.61X10^4$	$0.451/8.06X10^3$	$0.320/8.06X10^3$	-0.152
K	$1.228/7.74X10^3$	$0.493/3.87X10^3$	$0.437/3.87X10^3$	0.015
L	$0.978/6.04X10^3$	$0.592/3.02X10^3$	$0.510/3.02X10^3$	-0.006
6, M	$1.315/3.25X10^4$	$0.639/1.65X10^4$	$0.739/1.63X10^4$	0.099
N	$1.267/2.29X10^4$	$0.639/1.63X10^4$	$0.739/1.63X10^4$	0.099
O	$0.545/1.14X10^4$	$0.218/5.69X10^3$	$0.110/5.69X10^3$	-0.069
P	$0.544/5.69X10^3$	$0.403/2.84X10^3$	$0.358/2.84X10^3$	-0.039

CHAPTER V

CONCLUSIONS

This thesis was carried out for the purpose of studying the pressure distribution of an oscillating cylinder. From the evaluation of the results, it is observed that the frequency of oscillation as well as the amplitude of the displacement both have an effect on the angular distribution of pressure coefficient around the cylinder. The comparison was made between a given amplitude with period varying and it can be concluded that the pressure coefficient has greater variation for high amplitude and short period than for lower amplitude and longer period. In the same cycle of oscillation the force at the same velocity is low for deceleration and high for acceleration. At the point of zero velocity, the force is nonzero, but small. This force is due to the inertia effect of the fluid which has reversed direction during the deceleration of the oscillation period.

It is observed that the values of pressure coefficients are found to lie within the range of the theoretical steady flow values.

The data from this study form a part of an ongoing program at the University of Houston to determine an understanding of wave forces on offshore platforms. The results of this study will hopefully lead to an eventual better description of wave forces.

Further study in this area could be the investigation of the pressure distribution on pipelines that rest on the ocean floor and which are subjected to currents and waves.

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APPENDIX

INDEX OF APPENDIX TABLES

TABLE 3 (A)

ANG	U(MAX),ACCELERATION MV	PSI	CP	1/2U(MAX),ACCLERATION MV	PSI	CP	1/2U(MAX),DECELERATION MV	PSI	CP	U(ZERO) MV	PSI	CP
0	3.90	0.001755	1.00	1.00	0.000450	0.26	0.90	0.000405	0.23	-1.50	-0.000675	-0.39
10	3.70	0.001665	0.95	0.80	0.000360	0.21	0.80	0.000360	0.21	-1.00	-0.000450	-0.26
20	3.20	0.001440	0.82	0.50	0.000225	0.13	0.40	0.000180	0.10	-0.70	-0.000315	-0.18
30	3.50	0.001575	0.90	-0.10	-0.000045	-0.03	0.0	0.0	0.0	-0.60	-0.000270	-0.15
40	0.0	0.0	0.0	-1.10	-0.000495	-0.28	-0.90	-0.000405	-0.23	-0.60	-0.000270	-0.15
50	-3.20	-0.001440	-0.82	-2.00	-0.000900	-0.52	-1.80	-0.000810	-0.46	-0.80	-0.000360	-0.21
60	-4.50	-0.002025	-1.16	-3.00	-0.001350	-0.77	-3.00	-0.001350	-0.77	-1.10	-0.000495	-0.28
70	-7.00	-0.003150	-1.80	-4.50	-0.002025	-1.16	-4.90	-0.002205	-1.26	-2.60	-0.001170	-0.67
80	-10.50	-0.004725	-2.70	-6.60	-0.002970	-1.70	-6.20	-0.002790	-1.60	-3.00	-0.001350	-0.77
90	-10.50	-0.004725	-2.70	-6.70	-0.003015	-1.73	-5.80	-0.002610	-1.49	-2.50	-0.001125	-0.64
100	-9.10	-0.004095	-2.34	-5.40	-0.002430	-1.39	-4.70	-0.002115	-1.21	-1.80	-0.000810	-0.46
110	-7.00	-0.003150	-1.80	-4.50	-0.002025	-1.16	-4.20	-0.001890	-1.08	-1.70	-0.000765	-0.44
120	-4.70	-0.002115	-1.21	-4.00	-0.001800	-1.03	-3.80	-0.001710	-0.98	-1.80	-0.000810	-0.46
130	-4.70	-0.002115	-1.21	-3.80	-0.001710	-0.98	-3.20	-0.001440	-0.82	-1.40	-0.000630	-0.36
140	-4.50	-0.002025	-1.16	-3.00	-0.001350	-0.77	-2.50	-0.001125	-0.64	-1.40	-0.000630	-0.36
150	-3.70	-0.001665	-0.95	-3.20	-0.001440	-0.82	-1.60	-0.000720	-0.41	-0.70	-0.000315	-0.18
160	-3.30	-0.001485	-0.85	-1.80	-0.000810	-0.46	-1.00	-0.000450	-0.26	-0.40	-0.000180	-0.10
170	-2.90	-0.001305	-0.75	-1.40	-0.000630	-0.36	-0.90	-0.000405	-0.23	-0.40	-0.000180	-0.10
180	-2.90	-0.001305	-0.75	-1.30	-0.000585	-0.33	-0.80	-0.000360	-0.21	-0.30	-0.000135	-0.08
190	-3.00	-0.001350	-0.77	-1.50	-0.000675	-0.39	-1.00	-0.000450	-0.26	-0.45	-0.000202	-0.12
200	-3.30	-0.001485	-0.85	-1.70	-0.000765	-0.44	-1.10	-0.000495	-0.28	-0.46	-0.000207	-0.12
210	-3.60	-0.001620	-0.93	-3.10	-0.001395	-0.80	-1.50	-0.000675	-0.39	-0.65	-0.000292	-0.17
220	-4.60	-0.002070	-1.18	-3.10	-0.001395	-0.80	-2.60	-0.001170	-0.67	-1.40	-0.000630	-0.36
230	-4.70	-0.002115	-1.21	-3.90	-0.001755	-1.00	-3.30	-0.001485	-0.85	-1.50	-0.000675	-0.39
240	-4.90	-0.002205	-1.26	-4.10	-0.001845	-1.06	-3.70	-0.001665	-0.95	-1.80	-0.000810	-0.46
250	-7.20	-0.003240	-1.85	-4.60	-0.002070	-1.18	-4.10	-0.001845	-1.06	-1.70	-0.000765	-0.44
260	-9.20	-0.004140	-2.37	-5.30	-0.002385	-1.37	-4.90	-0.002205	-1.26	-1.80	-0.000810	-0.46
270	-10.50	-0.004725	-2.70	-6.80	-0.003060	-1.75	-5.90	-0.002655	-1.52	-2.40	-0.001080	-0.62
280	-10.40	-0.004680	-2.68	-6.50	-0.002925	-1.67	-6.00	-0.002700	-1.55	-3.10	-0.001395	-0.80
290	-7.20	-0.003240	-1.85	-4.60	-0.002070	-1.18	-4.90	-0.002205	-1.26	-2.60	-0.001170	-0.67
300	-4.60	-0.002070	-1.18	-3.20	-0.001440	-0.82	-3.20	-0.001440	-0.82	-1.10	-0.000495	-0.28
310	-3.10	-0.001395	-0.80	-2.10	-0.000945	-0.54	-1.90	-0.000855	-0.49	-0.80	-0.000360	-0.21
320	0.10	0.000045	0.03	-1.20	-0.000540	-0.31	-1.00	-0.000450	-0.26	-0.60	-0.000270	-0.15
330	2.50	0.001125	0.64	-0.30	-0.000135	-0.08	-0.10	-0.000045	-0.03	-0.65	-0.000292	-0.17
340	3.30	0.001485	0.85	0.70	0.000315	0.18	0.50	0.000225	0.13	-0.70	-0.000315	-0.18
350	3.60	0.001620	0.93	0.70	0.000315	0.18	0.90	0.000405	0.23	-1.00	-0.000450	-0.26
360	4.00	0.001800	1.03	1.20	0.000540	0.31	0.90	0.000405	0.23	-1.40	-0.000630	-0.36

TABLE 4 (B)

	U(MAX),ACCELERATION			1/2U(MAX),ACCLERATION			1/2U(MAX),DECELERATION			U(ZERO)		
ANG	MV	PSI	CP	MV	PSI	CP	MV	PSI	CP	MV	PSI	CP
0	2.10	0.000945	0.95	0.50	0.000225	0.23	0.40	0.000180	0.18	-1.00	-0.000450	-0.45
10	1.90	0.000855	0.86	0.30	0.000135	0.14	0.30	0.000135	0.14	-0.90	-0.000405	-0.41
20	1.40	0.000630	0.63	0.10	0.000045	0.05	0.0	0.0	0.0	-0.70	-0.000315	-0.32
30	0.30	0.000135	0.14	-0.50	-0.000225	-0.23	-0.30	-0.000135	-0.14	-0.70	-0.000315	-0.32
40	-1.20	-0.000540	-0.54	-1.50	-0.000675	-0.68	-0.70	-0.000315	-0.32	-0.65	-0.000292	-0.29
50	-1.90	-0.000855	-0.86	-1.90	-0.000855	-0.86	-1.70	-0.000765	-0.77	-0.72	-0.000324	-0.33
60	-3.70	-0.001665	-1.67	-2.40	-0.001080	-1.08	-2.00	-0.000900	-0.90	-1.00	-0.000450	-0.45
70	-4.70	-0.002115	-2.12	-3.30	-0.001485	-1.49	-2.30	-0.001035	-1.04	-1.40	-0.000630	-0.63
80	-5.90	-0.002655	-2.67	-3.80	-0.001710	-1.72	-3.20	-0.001440	-1.45	-1.40	-0.000630	-0.63
90	-5.70	-0.002565	-2.58	-3.80	-0.001710	-1.72	-3.00	-0.001350	-1.36	-1.20	-0.000540	-0.54
100	-4.50	-0.002025	-2.03	-2.60	-0.001170	-1.17	-2.00	-0.000900	-0.90	-1.10	-0.000495	-0.50
110	-2.70	-0.001215	-1.22	-2.00	-0.000900	-0.90	-1.80	-0.000810	-0.81	-1.20	-0.000540	-0.54
120	-2.60	-0.001170	-1.17	-2.00	-0.000900	-0.90	-1.80	-0.000810	-0.81	-1.20	-0.000540	-0.54
130	-2.70	-0.001215	-1.22	-1.90	-0.000855	-0.86	-1.70	-0.000765	-0.77	-1.20	-0.000540	-0.54
140	-2.30	-0.001035	-1.04	-1.80	-0.000810	-0.81	-1.50	-0.000675	-0.68	-0.90	-0.000405	-0.41
150	-2.30	-0.001035	-1.04	-1.80	-0.000810	-0.81	-1.40	-0.000630	-0.63	-0.70	-0.000315	-0.32
160	-2.30	-0.001035	-1.04	-1.80	-0.000810	-0.81	-1.40	-0.000630	-0.63	-0.50	-0.000225	-0.23
170	-2.20	-0.000990	-0.99	-1.70	-0.000765	-0.77	-1.40	-0.000630	-0.63	-0.30	-0.000135	-0.14
180	-2.20	-0.000990	-0.99	-1.70	-0.000765	-0.77	-1.50	-0.000675	-0.68	-0.30	-0.000135	-0.14
190	-2.30	-0.001035	-1.04	-1.80	-0.000810	-0.81	-1.50	-0.000675	-0.68	-0.40	-0.000180	-0.18
200	-2.40	-0.001080	-1.08	-1.90	-0.000855	-0.86	-1.30	-0.000585	-0.59	-0.40	-0.000180	-0.18
210	-2.40	-0.001080	-1.08	-1.90	-0.000855	-0.86	-1.40	-0.000630	-0.63	-0.80	-0.000360	-0.36
220	-2.30	-0.001035	-1.04	-1.80	-0.000810	-0.81	-1.40	-0.000630	-0.63	-1.00	-0.000450	-0.45
230	-2.60	-0.001170	-1.17	-1.90	-0.000855	-0.86	-1.60	-0.000720	-0.72	-0.90	-0.000405	-0.41
240	-2.50	-0.001125	-1.13	-2.10	-0.000945	-0.95	-1.90	-0.000855	-0.86	-1.10	-0.000495	-0.50
250	-2.90	-0.001305	-1.31	-2.10	-0.000945	-0.95	-1.70	-0.000765	-0.77	-1.20	-0.000540	-0.54
260	-4.50	-0.002025	-2.03	-2.50	-0.001125	-1.13	-1.90	-0.000855	-0.86	-1.10	-0.000495	-0.50
270	-5.60	-0.002520	-2.53	-3.90	-0.001755	-1.76	-3.10	-0.001395	-1.40	-1.20	-0.000540	-0.54
280	-6.00	-0.002700	-2.71	-3.80	-0.001710	-1.72	-3.20	-0.001440	-1.45	-1.40	-0.000630	-0.63
290	-4.90	-0.002205	-2.21	-3.30	-0.001485	-1.49	-2.30	-0.001035	-1.04	-1.30	-0.000585	-0.59
300	-3.80	-0.001710	-1.72	-2.40	-0.001080	-1.08	-2.00	-0.000900	-0.90	-1.10	-0.000495	-0.50
310	-2.00	-0.000900	-0.90	-1.90	-0.000855	-0.86	-1.70	-0.000765	-0.77	-0.70	-0.000315	-0.32
320	-1.20	-0.000540	-0.54	-1.60	-0.000720	-0.72	-0.80	-0.000360	-0.36	-0.60	-0.000270	-0.27
330	0.40	0.000180	0.18	-0.50	-0.000225	-0.23	-0.20	-0.000090	-0.09	-0.70	-0.000315	-0.32
340	1.50	0.000675	0.68	0.10	0.000045	0.05	0.0	0.0	0.0	-0.60	-0.000270	-0.27
350	2.00	0.000900	0.90	0.30	0.000135	0.14	0.30	0.000135	0.14	-0.80	-0.000360	-0.36
360	2.20	0.000990	0.99	0.50	0.000225	0.23	0.50	0.000225	0.23	-1.00	-0.000450	-0.45

TABLE 5 (C)

ANG	U(MAX),ACCELERATION MV	PSI	CP	1/2U(MAX),ACCLERATION MV	PSI	CP	1/2U(MAX),DECELERATION MV	PSI	CP	U(ZERO) MV	PSI	CP
0	1.10	0.000495	0.99	0.30	0.000135	0.27	0.20	0.000090	0.18	0.10	0.000045	0.09
10	1.00	0.000450	0.90	0.30	0.000135	0.27	0.20	0.000090	0.18	0.10	0.000045	0.09
20	0.90	0.000405	0.81	0.20	0.000090	0.18	0.20	0.000090	0.18	0.10	0.000045	0.09
30	0.50	0.000225	0.45	0.10	0.000045	0.09	0.10	0.000045	0.09	0.10	0.000045	0.09
40	0.0	0.0	0.0	-0.10	-0.000045	-0.09	0.0	0.0	0.0	0.20	0.000090	0.18
50	-0.30	-0.000135	-0.27	-0.30	-0.000135	-0.27	-0.10	-0.000045	-0.09	0.0	0.0	0.0
60	-0.70	-0.000315	-0.63	-0.50	-0.000225	-0.45	-0.50	-0.000225	-0.45	-0.20	-0.000090	-0.18
70	-1.20	-0.000540	-1.08	-0.70	-0.000315	-0.63	-0.60	-0.000270	-0.54	-0.20	-0.000090	-0.18
80	-1.80	-0.000810	-1.62	-1.10	-0.000495	-0.99	-0.80	-0.000360	-0.72	-0.10	-0.000045	-0.09
90	-2.30	-0.001035	-2.07	-1.50	-0.000675	-1.35	-1.10	-0.000495	-0.99	-0.20	-0.000090	-0.18
100	-2.30	-0.001035	-2.07	-1.60	-0.000720	-1.44	-1.10	-0.000495	-0.99	-0.10	-0.000045	-0.09
110	-2.10	-0.000945	-1.89	-1.10	-0.000495	-0.99	-0.90	-0.000405	-0.81	-0.20	-0.000090	-0.18
120	-1.60	-0.000720	-1.44	-0.90	-0.000405	-0.81	-0.70	-0.000315	-0.63	-0.30	-0.000135	-0.27
130	-0.80	-0.000360	-0.72	-0.70	-0.000315	-0.63	-0.60	-0.000270	-0.54	-0.10	-0.000045	-0.09
140	-0.70	-0.000315	-0.63	-0.60	-0.000270	-0.54	-0.50	-0.000225	-0.45	0.0	0.0	0.0
150	-0.70	-0.000315	-0.63	-0.60	-0.000270	-0.54	-0.40	-0.000180	-0.36	0.10	0.000045	0.09
160	-0.70	-0.000315	-0.63	-0.50	-0.000225	-0.45	-0.40	-0.000180	-0.36	-0.10	-0.000045	-0.09
170	-0.60	-0.000270	-0.54	-0.50	-0.000225	-0.45	-0.40	-0.000180	-0.36	-0.10	-0.000045	-0.09
180	-0.60	-0.000270	-0.54	-0.60	-0.000270	-0.54	-0.40	-0.000180	-0.36	0.0	0.0	0.0
190	-0.70	-0.000315	-0.63	-0.50	-0.000225	-0.45	-0.50	-0.000225	-0.45	0.10	0.000045	0.09
200	-0.70	-0.000315	-0.63	-0.50	-0.000225	-0.45	-0.50	-0.000225	-0.45	0.10	0.000045	0.09
210	-0.80	-0.000360	-0.72	-0.60	-0.000270	-0.54	-0.30	-0.000135	-0.27	0.10	0.000045	0.09
220	-0.70	-0.000315	-0.63	-0.70	-0.000315	-0.63	-0.60	-0.000270	-0.54	0.0	0.0	0.0
230	-0.80	-0.000360	-0.72	-0.80	-0.000360	-0.72	-0.60	-0.000270	-0.54	-0.10	-0.000045	-0.09
240	-0.15	-0.000067	-0.14	-0.90	-0.000405	-0.81	-0.70	-0.000315	-0.63	-0.20	-0.000090	-0.18
250	-1.90	-0.000855	-1.71	-1.20	-0.000540	-1.08	-1.00	-0.000450	-0.90	-0.20	-0.000090	-0.18
260	-2.20	-0.000990	-1.98	-1.70	-0.000765	-1.53	-1.20	-0.000540	-1.08	-0.10	-0.000045	-0.09
270	-2.30	-0.001035	-2.07	-1.40	-0.000630	-1.26	-1.30	-0.000585	-1.17	-0.10	-0.000045	-0.09
280	-1.80	-0.000810	-1.62	-1.20	-0.000540	-1.08	-0.90	-0.000405	-0.81	-0.20	-0.000090	-0.18
290	-1.20	-0.000540	-1.08	-0.70	-0.000315	-0.63	-0.70	-0.000315	-0.63	-0.20	-0.000090	-0.18
300	-0.70	-0.000315	-0.63	-0.60	-0.000270	-0.54	-0.40	-0.000180	-0.36	-0.10	-0.000045	-0.09
310	-0.20	-0.000090	-0.18	-0.30	-0.000135	-0.27	-0.10	-0.000045	-0.09	0.0	0.0	0.0
320	0.0	0.0	0.0	-0.10	-0.000045	-0.09	0.0	0.0	0.0	0.10	0.000045	0.09
330	0.60	0.000270	0.54	0.10	0.000045	0.09	0.20	0.000090	0.18	0.20	0.000090	0.18
340	0.90	0.000405	0.81	0.30	0.000135	0.27	0.30	0.000135	0.27	0.0	0.0	0.0
350	1.00	0.000450	0.90	0.20	0.000090	0.18	0.20	0.000090	0.18	-0.10	-0.000045	-0.09
360	1.20	0.000540	1.08	0.30	0.000135	0.27	0.30	0.000135	0.27	-0.10	-0.000045	-0.09

TABLE 6 (D)

ANG	U(MAX),ACCELERATION MV	PSI	CP	*	1/2U(MAX),ACCLERATION MV	PSI	CP	*	1/2U(MAX),DECELERATION MV	PSI	CP	*	U(ZERO) MV	PSI	CP
0	0.70	0.000315	0.96	*	0.20	0.000090	0.28	*	0.20	0.000090	0.28	*	0.0	0.0	0.0
10	0.60	0.000270	0.83	*	0.10	0.000045	0.14	*	0.10	0.000045	0.14	*	0.02	0.000009	0.03
20	0.40	0.000180	0.55	*	0.0	0.0	0.0	*	0.0	0.0	0.0	*	0.03	0.000013	0.04
30	-0.20	-0.000090	-0.28	*	-0.20	-0.000090	-0.28	*	-0.10	-0.000045	-0.14	*	0.02	0.000009	0.03
40	-0.30	-0.000135	-0.41	*	-0.30	-0.000135	-0.41	*	-0.20	-0.000090	-0.28	*	0.01	0.000004	0.01
50	-0.50	-0.000225	-0.69	*	-0.40	-0.000180	-0.55	*	-0.40	-0.000180	-0.55	*	-0.02	-0.000009	-0.03
60	-0.90	-0.000405	-1.24	*	-0.70	-0.000315	-0.96	*	-0.50	-0.000225	-0.69	*	-0.13	-0.000058	-0.18
70	-1.10	-0.000495	-1.51	*	-1.10	-0.000495	-1.51	*	-0.80	-0.000360	-1.10	*	-0.13	-0.000058	-0.18
80	-1.20	-0.000540	-1.65	*	-1.20	-0.000540	-1.65	*	-1.00	-0.000450	-1.38	*	-0.12	-0.000054	-0.17
90	-1.50	-0.000675	-2.07	*	-1.00	-0.000450	-1.38	*	-1.10	-0.000495	-1.51	*	-0.10	-0.000045	-0.14
100	-1.50	-0.000675	-2.07	*	-1.10	-0.000495	-1.51	*	-0.80	-0.000360	-1.10	*	-0.11	-0.000049	-0.15
110	-1.40	-0.000630	-1.93	*	-0.80	-0.000360	-1.10	*	-0.70	-0.000315	-0.96	*	-0.13	-0.000058	-0.18
120	-1.10	-0.000495	-1.51	*	-0.40	-0.000180	-0.55	*	-0.30	-0.000135	-0.41	*	-0.10	-0.000045	-0.14
130	-0.50	-0.000225	-0.69	*	-0.30	-0.000135	-0.41	*	-0.30	-0.000135	-0.41	*	-0.10	-0.000045	-0.14
140	-0.40	-0.000180	-0.55	*	-0.20	-0.000090	-0.28	*	-0.20	-0.000090	-0.28	*	-0.10	-0.000045	-0.14
150	-0.40	-0.000180	-0.55	*	-0.20	-0.000090	-0.28	*	-0.20	-0.000090	-0.28	*	0.0	0.0	0.0
160	-0.30	-0.000135	-0.41	*	-0.30	-0.000135	-0.41	*	-0.20	-0.000090	-0.28	*	0.08	0.000036	0.11
170	-0.40	-0.000180	-0.55	*	-0.30	-0.000135	-0.41	*	-0.10	-0.000045	-0.14	*	0.09	0.000040	0.12
180	-0.40	-0.000180	-0.55	*	-0.30	-0.000135	-0.41	*	-0.20	-0.000090	-0.28	*	0.10	0.000045	0.14
190	-0.50	-0.000225	-0.69	*	-0.30	-0.000135	-0.41	*	-0.21	-0.000094	-0.29	*	0.10	0.000045	0.14
200	-0.40	-0.000180	-0.55	*	-0.20	-0.000090	-0.28	*	-0.10	-0.000045	-0.14	*	0.10	0.000045	0.14
210	-0.40	-0.000180	-0.55	*	-0.20	-0.000090	-0.28	*	-0.20	-0.000090	-0.28	*	0.0	0.0	0.0
220	-0.40	-0.000180	-0.55	*	-0.30	-0.000135	-0.41	*	-0.20	-0.000090	-0.28	*	-0.10	-0.000045	-0.14
230	-0.60	-0.000270	-0.83	*	-0.30	-0.000135	-0.41	*	-0.20	-0.000090	-0.28	*	-0.10	-0.000045	-0.14
240	-1.00	-0.000450	-1.38	*	-0.50	-0.000225	-0.69	*	-0.30	-0.000135	-0.41	*	-0.20	-0.000090	-0.28
250	-1.30	-0.000585	-1.79	*	-0.80	-0.000360	-1.10	*	-0.60	-0.000270	-0.83	*	-0.10	-0.000045	-0.14
260	-1.50	-0.000675	-2.07	*	-1.00	-0.000450	-1.38	*	-0.90	-0.000405	-1.24	*	-0.10	-0.000045	-0.14
270	-1.40	-0.000630	-1.93	*	-1.20	-0.000540	-1.65	*	-1.00	-0.000450	-1.38	*	-0.10	-0.000045	-0.14
280	-1.30	-0.000585	-1.79	*	-1.10	-0.000495	-1.51	*	-1.00	-0.000450	-1.38	*	-0.15	-0.000067	-0.21
290	-1.20	-0.000540	-1.65	*	-0.90	-0.000405	-1.24	*	-0.80	-0.000360	-1.10	*	-0.10	-0.000045	-0.14
300	-0.90	-0.000405	-1.24	*	-0.70	-0.000315	-0.96	*	-0.60	-0.000270	-0.83	*	-0.14	-0.000063	-0.19
310	-0.60	-0.000270	-0.83	*	-0.50	-0.000225	-0.69	*	-0.40	-0.000180	-0.55	*	-0.13	-0.000058	-0.18
320	-0.40	-0.000180	-0.55	*	-0.40	-0.000180	-0.55	*	-0.30	-0.000135	-0.41	*	0.0	0.0	0.0
330	-0.20	-0.000090	-0.28	*	-0.30	-0.000135	-0.41	*	-0.20	-0.000090	-0.28	*	0.01	0.000004	0.01
340	0.50	0.000225	0.69	*	0.0	0.0	0.0	*	0.0	0.0	0.0	*	0.03	0.000013	0.04
350	0.70	0.000315	0.96	*	0.20	0.000090	0.28	*	0.10	0.000045	0.14	*	0.03	0.000013	0.04
360	0.70	0.000315	0.96	*	0.20	0.000090	0.28	*	0.20	0.000090	0.28	*	0.0	0.0	0.0

TABLE 7 (E)

	U(MAX),ACCELERATION			1/2U(MAX),ACCLERATION			1/2U(MAX),DECELERATION			U(ZERO)		
ANG	MV	PSI	CP	MV	PSI	CP	MV	PSI	CP	MV	PSI	CP
0	7.70	0.006930	0.99	1.80	0.001620	0.23	1.40	0.001260	0.18	-2.90	-0.002610	-0.37
10	7.00	0.006300	0.90	1.70	0.001530	0.22	1.00	0.000900	0.13	-2.40	-0.002160	-0.31
20	5.50	0.004950	0.70	0.70	0.000630	0.09	0.90	0.000810	0.12	-1.90	-0.001710	-0.24
30	3.10	0.002790	0.40	-0.60	-0.000540	-0.08	0.20	0.000180	0.03	-2.00	-0.001800	-0.26
40	-1.00	-0.000900	-0.13	-2.50	-0.002250	-0.32	-1.10	-0.000990	-0.14	-2.00	-0.001800	-0.26
50	-7.40	-0.006660	-0.95	-4.50	-0.004050	-0.58	-3.40	-0.003060	-0.43	-2.40	-0.002160	-0.31
60	-14.00	-0.012600	-1.79	-9.00	-0.008100	-1.15	-5.00	-0.004500	-0.64	-3.00	-0.002700	-0.38
70	-18.30	-0.016470	-2.34	-11.90	-0.010710	-1.52	-9.60	-0.008640	-1.23	-4.90	-0.004410	-0.63
80	-18.40	-0.016560	-2.35	-12.40	-0.011160	-1.59	-10.40	-0.009360	-1.33	-5.60	-0.005040	-0.72
90	-16.00	-0.014400	-2.05	-11.90	-0.010710	-1.52	-10.10	-0.009090	-1.29	-5.90	-0.005310	-0.75
100	-12.00	-0.010800	-1.54	-10.30	-0.009270	-1.32	-9.30	-0.008370	-1.19	-4.90	-0.004410	-0.63
110	-12.40	-0.011160	-1.59	-9.90	-0.008910	-1.27	-8.40	-0.007560	-1.07	-5.20	-0.004680	-0.67
120	-12.10	-0.010890	-1.55	-8.50	-0.007650	-1.09	-7.10	-0.006390	-0.91	-5.30	-0.004770	-0.68
130	-10.20	-0.009180	-1.30	-7.10	-0.006390	-0.91	-5.50	-0.004950	-0.70	-3.50	-0.003150	-0.45
140	-8.10	-0.007290	-1.04	-6.20	-0.005580	-0.79	-5.50	-0.004950	-0.70	-3.10	-0.002790	-0.40
150	-8.00	-0.007200	-1.02	-6.30	-0.005670	-0.81	-5.10	-0.004590	-0.65	-2.90	-0.002610	-0.37
160	-7.60	-0.006840	-0.97	-5.80	-0.005220	-0.74	-4.50	-0.004050	-0.58	-2.00	-0.001800	-0.26
170	-7.50	-0.006750	-0.96	-5.70	-0.005130	-0.73	-3.80	-0.003420	-0.49	-1.10	-0.000990	-0.14
180	-7.60	-0.006840	-0.97	-5.90	-0.005310	-0.75	-4.00	-0.003600	-0.51	-0.80	-0.000720	-0.10
190	-7.50	-0.006750	-0.96	-5.90	-0.005310	-0.75	-3.80	-0.003420	-0.49	-0.90	-0.000810	-0.12
200	-8.00	-0.007200	-1.02	-6.00	-0.005400	-0.77	-4.50	-0.004050	-0.58	-2.00	-0.001800	-0.26
210	-8.00	-0.007200	-1.02	-6.10	-0.005490	-0.78	-4.90	-0.004410	-0.63	-2.70	-0.002430	-0.35
220	-7.90	-0.007110	-1.01	-6.10	-0.005490	-0.78	-5.50	-0.004950	-0.70	-2.90	-0.002610	-0.37
230	-9.80	-0.008820	-1.25	-6.90	-0.006210	-0.88	-5.70	-0.005130	-0.73	-3.70	-0.003330	-0.47
240	-11.90	-0.010710	-1.52	-8.80	-0.007920	-1.13	-6.90	-0.006210	-0.88	-5.30	-0.004770	-0.68
250	-12.60	-0.011340	-1.61	-10.10	-0.009090	-1.29	-9.00	-0.008100	-1.15	-5.00	-0.004500	-0.64
260	-14.00	-0.012600	-1.79	-10.50	-0.009450	-1.34	-9.00	-0.008100	-1.15	-5.10	-0.004590	-0.65
270	-16.00	-0.014400	-2.05	-12.20	-0.010980	-1.56	-9.90	-0.008910	-1.27	-6.10	-0.005490	-0.78
280	-18.60	-0.016740	-2.38	-12.60	-0.011340	-1.61	-10.60	-0.009540	-1.36	-5.60	-0.005040	-0.72
290	-18.60	-0.016740	-2.38	-11.90	-0.010710	-1.52	-9.40	-0.008460	-1.20	-5.20	-0.004680	-0.67
300	-14.00	-0.012600	-1.79	-9.00	-0.008100	-1.15	-5.20	-0.004680	-0.67	-3.00	-0.002700	-0.38
310	-7.60	-0.006840	-0.97	-4.50	-0.004050	-0.58	-3.60	-0.003240	-0.46	-2.40	-0.002160	-0.31
320	-1.00	-0.000900	-0.13	-2.60	-0.002340	-0.33	-1.10	-0.000990	-0.14	-2.00	-0.001800	-0.26
330	3.30	0.002970	0.42	-0.80	-0.000720	-0.10	0.0	0.0	0.0	-1.60	-0.001440	-0.20
340	5.60	0.005040	0.72	0.90	0.000810	0.12	0.70	0.000630	0.09	-2.10	-0.001890	-0.27
350	7.00	0.006300	0.90	1.90	0.001710	0.24	0.80	0.000720	0.10	-2.60	-0.002340	-0.33
360	7.90	0.007110	1.01	2.00	0.001800	0.26	1.40	0.001260	0.18	-3.10	-0.002790	-0.40

TABLE 8 (F)

	U(MAX),ACCELERATION			1/2U(MAX),ACCLERATION			1/2U(MAX),DECELERATION			U(ZERO)		
ANG	MV	PSI	CP	MV	PSI	CP	MV	PSI	CP	MV	PSI	CP
0	4.10	0.003690	0.95	1.10	0.000990	0.26	0.60	0.000540	0.14	1.30	0.001170	0.30
10	3.70	0.003330	0.86	0.70	0.000630	0.16	0.40	0.000360	0.09	1.00	0.000900	0.23
20	2.30	0.002070	0.53	-0.40	-0.000360	-0.09	0.10	0.000090	0.02	-0.30	-0.000270	-0.07
30	-2.10	-0.001890	-0.49	-2.50	-0.002250	-0.58	-1.80	-0.001620	-0.42	-0.50	-0.000450	-0.12
40	-3.40	-0.003060	-0.79	-3.50	-0.003150	-0.81	-2.20	-0.001980	-0.51	-0.90	-0.000810	-0.21
50	-4.80	-0.004320	-1.11	-4.00	-0.003600	-0.93	-3.70	-0.003330	-0.86	-1.50	-0.001350	-0.35
60	-6.10	-0.005490	-1.42	-5.50	-0.004950	-1.28	-5.00	-0.004500	-1.16	-1.60	-0.001440	-0.37
70	-9.00	-0.008100	-2.09	-7.10	-0.006390	-1.65	-5.70	-0.005130	-1.32	-2.70	-0.002430	-0.63
80	-10.50	-0.009450	-2.44	-9.00	-0.008100	-2.09	-7.00	-0.006300	-1.63	-2.90	-0.002610	-0.67
90	-10.10	-0.009090	-2.34	-8.00	-0.007200	-1.86	-5.70	-0.005130	-1.32	-1.30	-0.001170	-0.30
100	-7.50	-0.006750	-1.74	-6.20	-0.005580	-1.44	-5.40	-0.004860	-1.25	-1.70	-0.001530	-0.39
110	-7.00	-0.006300	-1.63	-5.00	-0.004500	-1.16	-4.20	-0.003780	-0.98	-2.00	-0.001800	-0.46
120	-4.80	-0.004320	-1.11	-3.70	-0.003330	-0.86	-3.50	-0.003150	-0.81	-1.90	-0.001710	-0.44
130	-4.70	-0.004230	-1.09	-3.50	-0.003150	-0.81	-2.60	-0.002340	-0.60	-1.40	-0.001260	-0.33
140	-4.10	-0.003690	-0.95	-2.70	-0.002430	-0.63	-2.10	-0.001890	-0.49	-1.10	-0.000990	-0.26
150	-3.60	-0.003240	-0.84	-2.60	-0.002340	-0.60	-2.00	-0.001800	-0.46	-1.00	-0.000900	-0.23
160	-4.00	-0.003600	-0.93	-2.90	-0.002610	-0.67	-1.80	-0.001620	-0.42	-0.50	-0.000450	-0.12
170	-3.80	-0.003420	-0.88	-2.70	-0.002430	-0.63	-1.90	-0.001710	-0.44	-0.40	-0.000360	-0.09
180	-3.80	-0.003420	-0.88	-3.00	-0.002700	-0.70	-1.70	-0.001530	-0.39	-0.10	-0.000090	-0.02
190	-3.70	-0.003330	-0.86	-2.90	-0.002610	-0.67	-2.10	-0.001890	-0.49	-0.20	-0.000180	-0.05
200	-3.90	-0.003510	-0.91	-2.70	-0.002430	-0.63	-2.00	-0.001800	-0.46	-0.30	-0.000270	-0.07
210	-3.70	-0.003330	-0.86	-2.50	-0.002250	-0.58	-2.00	-0.001800	-0.46	-1.00	-0.000900	-0.23
220	-4.10	-0.003690	-0.95	-2.40	-0.002160	-0.56	-1.90	-0.001710	-0.44	-1.10	-0.000990	-0.26
230	-4.80	-0.004320	-1.11	-3.70	-0.003330	-0.86	-2.40	-0.002160	-0.56	-1.00	-0.000900	-0.23
240	-4.90	-0.004410	-1.14	-3.90	-0.003510	-0.91	-3.50	-0.003150	-0.81	-2.10	-0.001890	-0.49
250	-6.90	-0.006210	-1.60	-5.00	-0.004500	-1.16	-3.90	-0.003510	-0.91	-2.20	-0.001980	-0.51
260	-7.50	-0.006750	-1.74	-6.00	-0.005400	-1.39	-5.60	-0.005040	-1.30	-1.50	-0.001350	-0.35
270	-10.30	-0.009270	-2.39	-8.00	-0.007200	-1.86	-6.00	-0.005400	-1.39	-1.30	-0.001170	-0.30
280	-10.30	-0.009270	-2.39	-9.00	-0.008100	-2.09	-7.20	-0.006480	-1.67	-2.70	-0.002430	-0.63
290	-9.20	-0.008280	-2.14	-7.10	-0.006390	-1.65	-6.10	-0.005490	-1.42	-2.90	-0.002610	-0.67
300	-6.10	-0.005490	-1.42	-5.60	-0.005040	-1.30	-4.80	-0.004320	-1.11	-1.60	-0.001440	-0.37
310	-4.90	-0.004410	-1.14	-4.00	-0.003600	-0.93	-3.90	-0.003510	-0.91	-1.70	-0.001530	-0.39
320	-3.60	-0.003240	-0.84	-3.50	-0.003150	-0.81	-2.00	-0.001800	-0.46	-1.10	-0.000990	-0.26
330	-2.30	-0.002070	-0.53	-2.70	-0.002430	-0.63	-1.80	-0.001620	-0.42	-0.30	-0.000270	-0.07
340	2.40	0.002160	0.56	-0.60	-0.000540	-0.14	-0.10	-0.000090	-0.02	-0.30	-0.000270	-0.07
350	3.80	0.003420	0.88	0.70	0.000630	0.16	0.60	0.000540	0.14	-1.00	-0.000900	-0.23
360	4.10	0.003690	0.95	1.10	0.000990	0.26	1.00	0.000900	0.23	-1.30	-0.001170	-0.30

TABLE 9 (G)

	U(MAX),ACCELERATION			1/2U(MAX),ACCLERATION			1/2U(MAX),DECELERATION			U(ZERO)		
ANG	MV	PSI	CP	MV	PSI	CP	MV	PSI	CP	MV	PSI	CP
0	2.20	0.000990	0.99	0.50	0.000225	0.22	0.30	0.000135	0.13	-0.30	-0.000135	-0.13
10	2.00	0.000900	0.90	0.60	0.000270	0.27	0.20	0.000090	0.09	-0.20	-0.000090	-0.09
20	1.60	0.000720	0.72	0.30	0.000135	0.13	0.0	0.0	0.0	-0.20	-0.000090	-0.09
30	0.90	0.000405	0.40	-0.30	-0.000135	-0.13	-0.10	-0.000045	-0.04	-0.10	-0.000045	-0.04
40	-0.70	-0.000315	-0.31	-1.00	-0.000450	-0.45	-0.70	-0.000315	-0.31	-0.10	-0.000045	-0.04
50	-2.40	-0.001080	-1.08	-1.50	-0.000675	-0.67	-1.20	-0.000540	-0.54	-0.10	-0.000045	-0.04
60	-4.10	-0.001845	-1.84	-2.20	-0.000990	-0.99	-1.90	-0.000855	-0.85	-0.30	-0.000135	-0.13
70	-5.10	-0.002295	-2.29	-3.30	-0.001485	-1.48	-2.80	-0.001260	-1.26	-0.60	-0.000270	-0.27
80	-5.70	-0.002565	-2.56	-4.00	-0.001800	-1.80	-3.30	-0.001485	-1.48	-1.00	-0.000450	-0.45
90	-5.60	-0.002520	-2.52	-3.90	-0.001755	-1.75	-3.40	-0.001530	-1.53	-1.00	-0.000450	-0.45
100	-5.00	-0.002250	-2.25	-3.10	-0.001395	-1.39	-2.90	-0.001305	-1.30	-0.90	-0.000405	-0.40
110	-4.00	-0.001800	-1.80	-2.80	-0.001260	-1.26	-2.20	-0.000990	-0.99	-0.60	-0.000270	-0.27
120	-3.10	-0.001395	-1.39	-2.30	-0.001035	-1.03	-1.80	-0.000810	-0.81	-0.70	-0.000315	-0.31
130	-2.50	-0.001125	-1.12	-2.10	-0.000945	-0.94	-1.70	-0.000765	-0.76	-0.80	-0.000360	-0.36
140	-2.20	-0.000990	-0.99	-1.80	-0.000810	-0.81	-1.60	-0.000720	-0.72	-0.60	-0.000270	-0.27
150	-2.20	-0.000990	-0.99	-1.90	-0.000855	-0.85	-1.70	-0.000765	-0.76	-0.50	-0.000225	-0.22
160	-2.10	-0.000945	-0.94	-1.80	-0.000810	-0.81	-1.50	-0.000675	-0.67	-0.30	-0.000135	-0.13
170	-2.20	-0.000990	-0.99	-1.70	-0.000765	-0.76	-1.40	-0.000630	-0.63	-0.20	-0.000090	-0.09
180	-2.20	-0.000990	-0.99	-1.80	-0.000810	-0.81	-1.50	-0.000675	-0.67	0.0	0.0	0.0
190	-2.00	-0.000900	-0.90	-1.70	-0.000765	-0.76	-1.60	-0.000720	-0.72	0.0	0.0	0.0
200	-2.30	-0.001035	-1.03	-1.80	-0.000810	-0.81	-1.70	-0.000765	-0.76	-0.50	-0.000225	-0.22
210	-2.20	-0.000990	-0.99	-1.70	-0.000765	-0.76	-1.70	-0.000765	-0.76	-0.30	-0.000135	-0.13
220	-2.20	-0.000990	-0.99	-2.00	-0.000900	-0.90	-1.80	-0.000810	-0.81	-0.40	-0.000180	-0.18
230	-2.30	-0.001035	-1.03	-1.90	-0.000855	-0.85	-1.90	-0.000855	-0.85	-0.60	-0.000270	-0.27
240	-2.90	-0.001305	-1.30	-2.10	-0.000945	-0.94	-2.20	-0.000990	-0.99	-0.70	-0.000315	-0.31
250	-4.00	-0.001800	-1.80	-2.80	-0.001260	-1.26	-2.40	-0.001080	-1.08	-0.80	-0.000360	-0.36
260	-5.00	-0.002250	-2.25	-3.10	-0.001395	-1.39	-2.90	-0.001305	-1.30	-0.90	-0.000405	-0.40
270	-5.80	-0.002610	-2.61	-4.10	-0.001845	-1.84	-3.30	-0.001485	-1.48	-1.20	-0.000540	-0.54
280	-5.90	-0.002655	-2.65	-4.20	-0.001890	-1.89	-3.50	-0.001575	-1.57	-1.00	-0.000450	-0.45
290	-4.90	-0.002205	-2.20	-3.30	-0.001485	-1.48	-3.00	-0.001350	-1.35	-0.40	-0.000180	-0.18
300	-3.90	-0.001755	-1.75	-2.40	-0.001080	-1.08	-1.70	-0.000765	-0.76	-0.50	-0.000225	-0.22
310	-2.20	-0.000990	-0.99	-1.50	-0.000675	-0.67	-1.20	-0.000540	-0.54	-0.30	-0.000135	-0.13
320	-0.90	-0.000405	-0.40	-1.20	-0.000540	-0.54	-1.00	-0.000450	-0.45	-0.10	-0.000045	-0.04
330	0.70	0.000315	0.31	-0.50	-0.000225	-0.22	-0.30	-0.000135	-0.13	-0.10	-0.000045	-0.04
340	1.80	0.000810	0.81	0.10	0.000045	0.04	0.40	0.000180	0.18	-0.20	-0.000090	-0.09
350	2.20	0.000990	0.99	0.40	0.000180	0.18	0.40	0.000180	0.18	-0.40	-0.000180	-0.18
360	2.20	0.000990	0.99	0.70	0.000315	0.31	0.30	0.000135	0.13	-0.50	-0.000225	-0.22

TABLE 10 (H)

	U(MAX),ACCELERATION			1/2U(MAX),ACCLERATION			1/2U(MAX),DECELERATION			U(ZERO)		
ANG	MV	PSI	CP	MV	PSI	CP	MV	PSI	CP	MV	PSI	CP
0	1.40	0.000630	0.96	0.40	0.000180	0.28	0.50	0.000225	0.34	-0.30	-0.000135	-0.21
10	1.00	0.000450	0.69	0.30	0.000135	0.21	0.30	0.000135	0.21	-0.40	-0.000180	-0.28
20	0.50	0.000225	0.34	0.0	0.0	0.0	0.20	0.000090	0.14	-0.30	-0.000135	-0.21
30	-0.40	-0.000180	-0.28	-0.50	-0.000225	-0.34	-0.40	-0.000180	-0.28	-0.30	-0.000135	-0.21
40	-1.30	-0.000585	-0.89	-0.90	-0.000405	-0.62	-0.70	-0.000315	-0.48	-0.20	-0.000090	-0.14
50	-1.90	-0.000855	-1.31	-1.60	-0.000720	-1.10	-1.20	-0.000540	-0.83	-0.30	-0.000135	-0.21
60	-2.40	-0.001080	-1.65	-2.10	-0.000945	-1.44	-1.60	-0.000720	-1.10	-0.70	-0.000315	-0.48
70	-3.10	-0.001395	-2.13	-2.50	-0.001125	-1.72	-2.20	-0.000990	-1.51	-0.40	-0.000180	-0.28
80	-3.60	-0.001620	-2.48	-2.60	-0.001170	-1.79	-2.10	-0.000945	-1.44	-0.40	-0.000180	-0.28
90	-3.50	-0.001575	-2.41	-2.30	-0.001035	-1.58	-1.60	-0.000720	-1.10	-0.40	-0.000180	-0.28
100	-3.20	-0.001440	-2.20	-1.90	-0.000855	-1.31	-1.50	-0.000675	-1.03	-0.20	-0.000090	-0.14
110	-2.10	-0.000945	-1.44	-1.70	-0.000765	-1.17	-1.20	-0.000540	-0.83	-0.40	-0.000180	-0.28
120	-1.90	-0.000855	-1.31	-1.40	-0.000630	-0.96	-1.10	-0.000495	-0.76	-0.40	-0.000180	-0.28
130	-1.50	-0.000675	-1.03	-1.10	-0.000495	-0.76	-0.80	-0.000360	-0.55	-0.40	-0.000180	-0.28
140	-1.30	-0.000585	-0.89	-1.00	-0.000450	-0.69	-0.90	-0.000405	-0.62	-0.30	-0.000135	-0.21
150	-1.20	-0.000540	-0.83	-1.00	-0.000450	-0.69	-1.00	-0.000450	-0.69	-0.40	-0.000180	-0.28
160	-1.20	-0.000540	-0.83	-1.00	-0.000450	-0.69	-0.70	-0.000315	-0.48	-0.20	-0.000090	-0.14
170	-1.10	-0.000495	-0.76	-1.20	-0.000540	-0.83	-0.80	-0.000360	-0.55	-0.20	-0.000090	-0.14
180	-1.10	-0.000495	-0.76	-1.00	-0.000450	-0.69	-0.90	-0.000405	-0.62	-0.20	-0.000090	-0.14
190	-1.20	-0.000540	-0.83	-0.80	-0.000360	-0.55	-0.80	-0.000360	-0.55	-0.20	-0.000090	-0.14
200	-1.20	-0.000540	-0.83	-1.20	-0.000540	-0.83	-0.90	-0.000405	-0.62	-0.30	-0.000135	-0.21
210	-1.40	-0.000630	-0.96	-1.10	-0.000495	-0.76	-0.80	-0.000360	-0.55	-0.10	-0.000045	-0.07
220	-1.30	-0.000585	-0.89	-1.20	-0.000540	-0.83	-0.90	-0.000405	-0.62	-0.40	-0.000180	-0.28
230	-1.50	-0.000675	-1.03	-1.30	-0.000585	-0.89	-1.00	-0.000450	-0.69	-0.40	-0.000180	-0.28
240	-1.70	-0.000765	-1.17	-1.20	-0.000540	-0.83	-1.10	-0.000495	-0.76	-0.40	-0.000180	-0.28
250	-2.30	-0.001035	-1.58	-1.70	-0.000765	-1.17	-1.40	-0.000630	-0.96	-0.20	-0.000090	-0.14
260	-3.20	-0.001440	-2.20	-2.10	-0.000945	-1.44	-1.50	-0.000675	-1.03	-0.40	-0.000180	-0.28
270	-3.50	-0.001575	-2.41	-2.50	-0.001125	-1.72	-1.80	-0.000810	-1.24	-0.20	-0.000090	-0.14
280	-3.40	-0.001530	-2.34	-2.60	-0.001170	-1.79	-2.10	-0.000945	-1.44	-0.40	-0.000180	-0.28
290	-2.90	-0.001305	-1.99	-2.50	-0.001125	-1.72	-2.00	-0.000900	-1.38	-0.60	-0.000270	-0.41
300	-2.60	-0.001170	-1.79	-2.30	-0.001035	-1.58	-1.60	-0.000720	-1.10	-0.50	-0.000225	-0.34
310	-1.70	-0.000765	-1.17	-0.70	-0.000315	-0.48	-1.20	-0.000540	-0.83	-0.30	-0.000135	-0.21
320	-1.10	-0.000495	-0.76	-0.70	-0.000315	-0.48	-0.70	-0.000315	-0.48	-0.10	-0.000045	-0.07
330	-0.20	-0.000090	-0.14	-0.30	-0.000135	-0.21	-0.20	-0.000090	-0.14	-0.10	-0.000045	-0.07
340	0.70	0.000315	0.48	0.0	0.0	0.0	0.0	0.0	0.0	-0.10	-0.000045	-0.07
350	1.30	0.000585	0.89	0.30	0.000135	0.21	0.10	0.000045	0.07	-0.10	-0.000045	-0.07
360	1.60	0.000720	1.10	0.40	0.000180	0.28	0.20	0.000090	0.14	-0.30	-0.000135	-0.21

TABLE 11 (I)

ANG	U(MAX), ACCELERATION MV	PSI	CP	1/2U(MAX), ACCLERATION MV	PSI	CP	1/2U(MAX), DECELERATION MV	PSI	CP	U(ZERO) MV	PSI	CP
0	6.00	0.027000	0.98	1.30	0.005850	0.21	0.80	0.003600	0.13	-4.00	-0.018000	-0.65
10	5.00	0.022500	0.82	1.10	0.004950	0.18	0.70	0.003150	0.11	-3.50	-0.015750	-0.57
20	2.50	0.011250	0.41	-1.50	-0.006750	-0.24	0.0	0.0	0.0	-3.10	-0.013950	-0.51
30	-3.90	-0.017550	-0.64	-4.20	-0.018900	-0.69	-3.10	-0.013950	-0.51	-3.20	-0.014400	-0.52
40	-8.00	-0.036000	-1.31	-6.00	-0.027000	-0.98	-5.00	-0.022500	-0.82	-4.00	-0.018000	-0.65
50	-9.10	-0.040950	-1.49	-8.20	-0.036900	-1.34	-7.20	-0.032400	-1.18	-4.90	-0.022050	-0.80
60	-13.40	-0.060300	-2.19	-10.00	-0.045000	-1.63	-8.60	-0.038700	-1.40	-4.70	-0.021150	-0.77
70	-16.50	-0.074250	-2.69	-14.00	-0.063000	-2.29	-11.00	-0.049500	-1.80	-5.30	-0.023850	-0.87
80	-17.90	-0.080550	-2.92	-14.20	-0.063900	-2.32	-11.70	-0.052650	-1.91	-6.40	-0.028800	-1.04
90	-17.10	-0.076950	-2.79	-13.70	-0.061650	-2.24	-11.10	-0.049950	-1.81	-6.80	-0.030600	-1.11
100	-13.60	-0.061200	-2.22	-12.50	-0.056250	-2.04	-11.30	-0.050850	-1.84	-5.50	-0.024750	-0.90
110	-13.50	-0.060750	-2.20	-11.60	-0.052200	-1.89	-9.60	-0.043200	-1.57	-5.40	-0.024300	-0.88
120	-12.20	-0.054900	-1.99	-10.10	-0.045450	-1.65	-9.50	-0.042750	-1.55	-5.40	-0.024300	-0.88
130	-11.50	-0.051750	-1.88	-9.50	-0.042750	-1.55	-9.10	-0.040950	-1.49	-4.70	-0.021150	-0.77
140	-10.20	-0.045900	-1.66	-8.80	-0.039600	-1.44	-8.00	-0.036000	-1.31	-4.60	-0.020700	-0.75
150	-10.10	-0.045450	-1.65	-8.60	-0.038700	-1.40	-7.60	-0.034200	-1.24	-3.30	-0.014850	-0.54
160	-10.10	-0.045450	-1.65	-7.80	-0.035100	-1.27	-7.80	-0.035100	-1.27	-3.10	-0.013950	-0.51
170	-10.00	-0.045000	-1.63	-7.40	-0.033300	-1.21	-7.20	-0.032400	-1.18	-2.60	-0.011700	-0.42
180	-10.00	-0.045000	-1.63	-7.40	-0.033300	-1.21	-7.30	-0.032850	-1.19	-2.50	-0.011250	-0.41
190	-9.80	-0.044100	-1.60	-7.80	-0.035100	-1.27	-7.70	-0.034650	-1.26	-2.60	-0.011700	-0.42
200	-10.10	-0.045450	-1.65	-7.50	-0.033750	-1.22	-7.50	-0.033750	-1.22	-2.90	-0.013050	-0.47
210	-10.20	-0.045900	-1.66	-8.40	-0.037800	-1.37	-7.40	-0.033300	-1.21	-3.10	-0.013950	-0.51
220	-10.30	-0.046350	-1.68	-8.80	-0.039600	-1.44	-7.90	-0.035550	-1.29	-4.60	-0.020700	-0.75
230	-11.50	-0.051750	-1.88	-9.50	-0.042750	-1.55	-8.90	-0.040050	-1.45	-4.00	-0.018000	-0.65
240	-12.00	-0.054000	-1.96	-9.90	-0.044550	-1.62	-9.50	-0.042750	-1.55	-5.40	-0.024300	-0.88
250	-13.50	-0.060750	-2.20	-11.40	-0.051300	-1.86	-9.60	-0.043200	-1.57	-5.60	-0.025200	-0.91
260	-13.40	-0.060300	-2.19	-12.60	-0.056700	-2.06	-11.10	-0.049950	-1.81	-5.50	-0.024750	-0.90
270	-16.90	-0.076050	-2.76	-13.80	-0.062100	-2.25	-10.90	-0.049050	-1.78	-6.80	-0.030600	-1.11
280	-17.60	-0.079200	-2.87	-13.90	-0.062550	-2.27	-11.70	-0.052650	-1.91	-6.80	-0.030600	-1.11
290	-16.50	-0.074250	-2.69	-13.80	-0.062100	-2.25	-11.00	-0.049500	-1.80	-5.10	-0.022950	-0.83
300	-13.60	-0.061200	-2.22	-10.00	-0.045000	-1.63	-8.40	-0.037800	-1.37	-4.70	-0.021150	-0.77
310	-8.90	-0.040050	-1.45	-7.80	-0.035100	-1.27	-6.80	-0.030600	-1.11	-4.70	-0.021150	-0.77
320	-8.00	-0.036000	-1.31	-6.00	-0.027000	-0.98	-5.00	-0.022500	-0.82	-4.00	-0.018000	-0.65
330	-4.10	-0.018450	-0.67	-4.80	-0.021600	-0.78	-2.90	-0.013050	-0.47	-2.80	-0.012600	-0.46
340	2.50	0.011250	0.41	-1.50	-0.006750	-0.24	0.0	0.0	0.0	-2.90	-0.013050	-0.47
350	5.40	0.024300	0.88	0.90	0.004050	0.15	0.90	0.004050	0.15	-3.50	-0.015750	-0.57
360	6.00	0.027000	0.98	1.70	0.007650	0.28	1.20	0.005400	0.20	-4.00	-0.018000	-0.65

TABLE 12 (J)

	U(MAX),ACCELERATION			1/2U(MAX),ACCLERATION			1/2U(MAX),DECELERATION			U(ZERO)		
ANG	MV	PSI	CP	MV	PSI	CP	MV	PSI	CP	MV	PSI	CP
0	6.20	0.013950	0.98	1.60	0.003600	0.25	1.20	0.002700	0.19	-3.10	-0.006975	-0.49
10	5.40	0.012150	0.85	1.30	0.002925	0.21	1.10	0.002475	0.17	-2.60	-0.005850	-0.41
20	4.00	0.009000	0.63	0.10	0.000225	0.02	0.60	0.001350	0.09	-2.10	-0.004725	-0.33
30	0.60	0.001350	0.09	-2.10	-0.004725	-0.33	-1.50	-0.003375	-0.24	-2.00	-0.004500	-0.32
40	-1.60	-0.003600	-0.25	-2.30	-0.005175	-0.36	-2.30	-0.005175	-0.36	-2.10	-0.004725	-0.33
50	-3.20	-0.007200	-0.51	-3.30	-0.007425	-0.52	-3.20	-0.007200	-0.51	-3.10	-0.006975	-0.49
60	-10.30	-0.023175	-1.63	-5.70	-0.012825	-0.90	-4.50	-0.010125	-0.71	-3.60	-0.008100	-0.57
70	-14.50	-0.032625	-2.29	-10.60	-0.023850	-1.67	-6.50	-0.014625	-1.03	-3.70	-0.008325	-0.58
80	-16.00	-0.036000	-2.53	-11.40	-0.025650	-1.80	-7.40	-0.016650	-1.17	-4.00	-0.009000	-0.63
90	-15.10	-0.033975	-2.38	-11.10	-0.024975	-1.75	-7.50	-0.016875	-1.18	-4.60	-0.010350	-0.73
100	-12.40	-0.027900	-1.96	-9.10	-0.020475	-1.44	-6.30	-0.014175	-0.99	-4.00	-0.009000	-0.63
110	-9.60	-0.021600	-1.52	-8.60	-0.019350	-1.36	-6.40	-0.014400	-1.01	-3.10	-0.006975	-0.49
120	-10.00	-0.022500	-1.58	-7.00	-0.015750	-1.11	-5.50	-0.012375	-0.87	-3.20	-0.007200	-0.51
130	-7.60	-0.017100	-1.20	-6.20	-0.013950	-0.98	-4.60	-0.010350	-0.73	-3.10	-0.006975	-0.49
140	-7.20	-0.016200	-1.14	-5.70	-0.012825	-0.90	-4.50	-0.010125	-0.71	-2.10	-0.004725	-0.33
150	-7.00	-0.015750	-1.11	-4.90	-0.011025	-0.77	-3.40	-0.007650	-0.54	-1.70	-0.003825	-0.27
160	-6.40	-0.014400	-1.01	-4.20	-0.009450	-0.66	-2.50	-0.005625	-0.39	-1.50	-0.003375	-0.24
170	-6.50	-0.014625	-1.03	-3.30	-0.007425	-0.52	-2.10	-0.004725	-0.33	0.0	0.0	0.0
180	-6.50	-0.014625	-1.03	-3.30	-0.007425	-0.52	-2.00	-0.004500	-0.32	-0.50	-0.001125	-0.08
190	-6.50	-0.014625	-1.03	-3.50	-0.007875	-0.55	-2.30	-0.005175	-0.36	-0.20	-0.000450	-0.03
200	-6.40	-0.014400	-1.01	-3.80	-0.008550	-0.60	-2.70	-0.006075	-0.43	-1.50	-0.003375	-0.24
210	-7.00	-0.015750	-1.11	-4.70	-0.010575	-0.74	-3.40	-0.007650	-0.54	-1.50	-0.003375	-0.24
220	-7.20	-0.016200	-1.14	-5.70	-0.012825	-0.90	-4.50	-0.010125	-0.71	-1.90	-0.004275	-0.30
230	-7.40	-0.016650	-1.17	-5.80	-0.013050	-0.92	-4.60	-0.010350	-0.73	-2.90	-0.006525	-0.46
240	-10.00	-0.022500	-1.58	-7.00	-0.015750	-1.11	-4.90	-0.011025	-0.77	-3.00	-0.006750	-0.47
250	-9.60	-0.021600	-1.52	-8.40	-0.018900	-1.33	-6.40	-0.014400	-1.01	-2.90	-0.006525	-0.46
260	-12.60	-0.028350	-1.99	-8.90	-0.020025	-1.41	-6.90	-0.015525	-1.09	-4.00	-0.009000	-0.63
270	-14.90	-0.033525	-2.35	-10.90	-0.024525	-1.72	-7.50	-0.016875	-1.18	-4.40	-0.009900	-0.69
280	-16.00	-0.036000	-2.53	-11.60	-0.026100	-1.83	-7.60	-0.017100	-1.20	-4.30	-0.009675	-0.68
290	-14.50	-0.032625	-2.29	-10.60	-0.023850	-1.67	-6.50	-0.014625	-1.03	-3.50	-0.007875	-0.55
300	-10.70	-0.024075	-1.69	-5.70	-0.012825	-0.90	-4.50	-0.010125	-0.71	-3.60	-0.008100	-0.57
310	-2.80	-0.006300	-0.44	-3.50	-0.007875	-0.55	-2.80	-0.006300	-0.44	-2.90	-0.006525	-0.46
320	-1.60	-0.003600	-0.25	-2.70	-0.006075	-0.43	-2.30	-0.005175	-0.36	-1.90	-0.004275	-0.30
330	0.40	0.000900	0.06	-1.90	-0.004275	-0.30	-1.50	-0.003375	-0.24	-2.00	-0.004500	-0.32
340	4.00	0.009000	0.63	0.30	0.000675	0.05	0.40	0.000900	0.06	-1.90	-0.004275	-0.30
350	5.60	0.012600	0.88	1.30	0.002925	0.21	0.90	0.002025	0.14	-2.40	-0.005400	-0.38
360	6.40	0.014400	1.01	1.40	0.003150	0.22	0.80	0.001800	0.13	-2.90	-0.006525	-0.46

TABLE 13 (K)

ANG	U(MAX),ACCELERATION MV	PSI	CP	1/2U(MAX),ACCLERATION MV	PSI	CP	1/2U(MAX),DECELERATION MV	PSI	CP	U(ZERO) MV	PSI	CP
0	5.50	0.003162	0.96	1.50	0.000862	0.26	1.20	0.000690	0.21	-1.60	-0.000920	-0.28
10	5.30	0.003047	0.93	1.40	0.000805	0.25	1.00	0.000575	0.18	-1.30	-0.000747	-0.23
20	4.70	0.002702	0.82	1.00	0.000575	0.18	0.70	0.000402	0.12	-1.20	-0.000690	-0.21
30	3.20	0.001840	0.56	0.80	0.000460	0.14	0.30	0.000172	0.05	-1.10	-0.000632	-0.19
40	-0.90	-0.000517	-0.16	-1.20	-0.000690	-0.21	-0.20	-0.000115	-0.04	-1.20	-0.000690	-0.21
50	-3.40	-0.001955	-0.60	-2.80	-0.001610	-0.49	-1.20	-0.000690	-0.21	-1.20	-0.000690	-0.21
60	-5.00	-0.002875	-0.88	-3.60	-0.002070	-0.63	-2.60	-0.001495	-0.46	-1.30	-0.000747	-0.23
70	-11.70	-0.006727	-2.05	-6.50	-0.003737	-1.14	-3.60	-0.002070	-0.63	-1.80	-0.001035	-0.32
80	-12.60	-0.007245	-2.21	-8.70	-0.005002	-1.53	-5.40	-0.003105	-0.95	-2.00	-0.001150	-0.35
90	-12.70	-0.007302	-2.23	-8.80	-0.005060	-1.54	-5.70	-0.003277	-1.00	-1.80	-0.001035	-0.32
100	-11.50	-0.006612	-2.02	-7.50	-0.004312	-1.32	-4.90	-0.002817	-0.86	-1.50	-0.000862	-0.26
110	-9.60	-0.005520	-1.68	-5.40	-0.003105	-0.95	-3.60	-0.002070	-0.63	-1.60	-0.000920	-0.28
120	-7.00	-0.004025	-1.23	-3.90	-0.002242	-0.68	-3.30	-0.001897	-0.58	-1.80	-0.001035	-0.32
130	-6.60	-0.003795	-1.16	-3.50	-0.002012	-0.61	-3.00	-0.001725	-0.53	-1.60	-0.000920	-0.28
140	-6.30	-0.003622	-1.11	-3.30	-0.001897	-0.58	-2.90	-0.001667	-0.51	-1.40	-0.000805	-0.25
150	-5.60	-0.003220	-0.98	-3.20	-0.001840	-0.56	-2.80	-0.001610	-0.49	-1.50	-0.000862	-0.26
160	-5.80	-0.003335	-1.02	-3.60	-0.002070	-0.63	-2.70	-0.001552	-0.47	-1.40	-0.000805	-0.25
170	-5.80	-0.003335	-1.02	-3.30	-0.001897	-0.58	-2.80	-0.001610	-0.49	-1.00	-0.000575	-0.18
180	-5.80	-0.003335	-1.02	-3.20	-0.001840	-0.56	-2.50	-0.001437	-0.44	-0.80	-0.000460	-0.14
190	-5.80	-0.003335	-1.02	-3.30	-0.001897	-0.58	-2.40	-0.001380	-0.42	-1.00	-0.000575	-0.18
200	-5.90	-0.003392	-1.03	-3.20	-0.001840	-0.56	-2.70	-0.001552	-0.47	-1.20	-0.000690	-0.21
210	-5.70	-0.003277	-1.00	-3.20	-0.001840	-0.56	-2.60	-0.001495	-0.46	-1.30	-0.000747	-0.23
220	-6.30	-0.003622	-1.11	-3.30	-0.001897	-0.58	-2.90	-0.001667	-0.51	-1.40	-0.000805	-0.25
230	-6.70	-0.003852	-1.18	-3.20	-0.001840	-0.56	-3.00	-0.001725	-0.53	-1.40	-0.000805	-0.25
240	-7.10	-0.004082	-1.25	-3.70	-0.002127	-0.65	-2.90	-0.001667	-0.51	-1.60	-0.000920	-0.28
250	-9.40	-0.005405	-1.65	-5.10	-0.002932	-0.89	-3.60	-0.002070	-0.63	-1.60	-0.000920	-0.28
260	-11.50	-0.006612	-2.02	-7.50	-0.004312	-1.32	-4.70	-0.002702	-0.82	-1.50	-0.000862	-0.26
270	-12.50	-0.007187	-2.19	-8.80	-0.005060	-1.54	-5.90	-0.003392	-1.03	-1.60	-0.000920	-0.28
280	-12.60	-0.007245	-2.21	-8.90	-0.005117	-1.56	-5.20	-0.002990	-0.91	-1.80	-0.001035	-0.32
290	-11.30	-0.006497	-1.98	-6.50	-0.003737	-1.14	-3.40	-0.001955	-0.60	-1.80	-0.001035	-0.32
300	-5.00	-0.002875	-0.88	-3.40	-0.001955	-0.60	-2.40	-0.001380	-0.42	-1.50	-0.000862	-0.26
310	-3.20	-0.001840	-0.56	-2.80	-0.001610	-0.49	-1.20	-0.000690	-0.21	-1.00	-0.000575	-0.18
320	-0.80	-0.000460	-0.14	-0.80	-0.000460	-0.14	-0.20	-0.000115	-0.04	-0.80	-0.000460	-0.14
330	2.80	0.001610	0.49	0.80	0.000460	0.14	0.10	0.000057	0.02	-0.90	-0.000517	-0.16
340	4.70	0.002702	0.82	1.00	0.000575	0.18	0.70	0.000402	0.12	-0.90	-0.000517	-0.16
350	5.10	0.002932	0.89	1.20	0.000690	0.21	0.80	0.000460	0.14	-1.30	-0.000747	-0.23
360	5.50	0.003162	0.96	1.30	0.000747	0.23	0.80	0.000460	0.14	-1.40	-0.000805	-0.25

TABLE 14 (L)

ANG	U(MAX),ACCELERATION MV	PSI	CP	1/2U(MAX),ACCLERATION MV	PSI	CP	1/2U(MAX),DECELERATION MV	PSI	CP	U(ZERO) MV	PSI	CP
0	3.70	0.002127	1.07	1.00	0.000575	0.29	0.40	0.000230	0.12	-1.10	-0.000632	-0.32
10	3.50	0.002012	1.01	0.80	0.000460	0.23	0.50	0.000287	0.14	-0.80	-0.000460	-0.23
20	2.60	0.001495	0.75	0.60	0.000345	0.17	0.40	0.000230	0.12	-0.70	-0.000402	-0.20
30	0.80	0.000460	0.23	-0.20	-0.000115	-0.06	0.30	0.000172	0.09	-0.60	-0.000345	-0.17
40	-1.80	-0.001035	-0.52	-1.50	-0.000862	-0.43	-1.20	-0.000690	-0.35	-0.70	-0.000402	-0.20
50	-2.90	-0.001667	-0.84	-2.40	-0.001380	-0.69	-1.80	-0.001035	-0.52	-1.00	-0.000575	-0.29
60	-6.10	-0.003507	-1.76	-3.60	-0.002070	-1.04	-2.60	-0.001495	-0.75	-1.30	-0.000747	-0.37
70	-8.20	-0.004715	-2.36	-5.40	-0.003105	-1.55	-3.90	-0.002242	-1.12	-1.40	-0.000805	-0.40
80	-8.90	-0.005117	-2.56	-6.00	-0.003450	-1.73	-4.60	-0.002645	-1.32	-1.50	-0.000862	-0.43
90	-8.60	-0.004945	-2.48	-5.10	-0.002932	-1.47	-4.20	-0.002415	-1.21	-1.40	-0.000805	-0.40
100	-7.10	-0.004082	-2.04	-4.80	-0.002760	-1.38	-4.00	-0.002300	-1.15	-1.10	-0.000632	-0.32
110	-5.20	-0.002990	-1.50	-5.30	-0.003047	-1.53	-3.50	-0.002012	-1.01	-1.10	-0.000632	-0.32
120	-5.10	-0.002932	-1.47	-3.90	-0.002242	-1.12	-3.00	-0.001725	-0.86	-1.00	-0.000575	-0.29
130	-4.10	-0.002357	-1.18	-3.10	-0.001782	-0.89	-2.60	-0.001495	-0.75	-1.20	-0.000690	-0.35
140	-3.50	-0.002012	-1.01	-3.00	-0.001725	-0.86	-2.70	-0.001552	-0.78	-1.20	-0.000690	-0.35
150	-3.60	-0.002070	-1.04	-2.90	-0.001667	-0.84	-2.50	-0.001437	-0.72	-0.80	-0.000460	-0.23
160	-3.40	-0.001955	-0.98	-2.80	-0.001610	-0.81	-2.00	-0.001150	-0.58	-0.80	-0.000460	-0.23
170	-3.20	-0.001840	-0.92	-2.60	-0.001495	-0.75	-2.10	-0.001207	-0.60	-0.60	-0.000345	-0.17
180	-3.20	-0.001840	-0.92	-2.50	-0.001437	-0.72	-1.80	-0.001035	-0.52	-0.40	-0.000230	-0.12
190	-3.20	-0.001840	-0.92	-2.40	-0.001380	-0.69	-2.10	-0.001207	-0.60	-0.40	-0.000230	-0.12
200	-3.20	-0.001840	-0.92	-2.60	-0.001495	-0.75	-2.40	-0.001380	-0.69	-0.80	-0.000460	-0.23
210	-3.40	-0.001955	-0.98	-2.90	-0.001667	-0.84	-2.30	-0.001322	-0.66	-1.00	-0.000575	-0.29
220	-3.50	-0.002012	-1.01	-2.80	-0.001610	-0.81	-2.50	-0.001437	-0.72	-1.00	-0.000575	-0.29
230	-3.90	-0.002242	-1.12	-2.90	-0.001667	-0.84	-2.40	-0.001380	-0.69	-1.20	-0.000690	-0.35
240	-4.90	-0.002817	-1.41	-3.70	-0.002127	-1.07	-3.00	-0.001725	-0.86	-1.00	-0.000575	-0.29
250	-5.20	-0.002990	-1.50	-4.30	-0.002472	-1.24	-3.50	-0.002012	-1.01	-0.90	-0.000517	-0.26
260	-6.90	-0.003967	-1.99	-4.80	-0.002760	-1.38	-3.80	-0.002185	-1.09	-1.10	-0.000632	-0.32
270	-8.40	-0.004830	-2.42	-5.30	-0.003047	-1.53	-4.00	-0.002300	-1.15	-1.20	-0.000690	-0.35
280	-8.70	-0.005002	-2.51	-6.00	-0.003450	-1.73	-4.40	-0.002530	-1.27	-1.50	-0.000862	-0.43
290	-8.20	-0.004715	-2.36	-5.40	-0.003105	-1.55	-3.90	-0.002242	-1.12	-1.60	-0.000920	-0.46
300	-5.90	-0.003392	-1.70	-3.40	-0.001955	-0.98	-2.60	-0.001495	-0.75	-1.50	-0.000862	-0.43
310	-2.70	-0.001552	-0.78	-2.40	-0.001380	-0.69	-2.00	-0.001150	-0.58	-1.10	-0.000632	-0.32
320	-1.80	-0.001035	-0.52	-1.50	-0.000862	-0.43	-0.80	-0.000460	-0.23	-0.90	-0.000517	-0.26
330	0.60	0.000345	0.17	0.0	0.0	0.0	0.10	0.000057	0.03	-0.60	-0.000345	-0.17
340	2.80	0.001610	0.81	0.40	0.000230	0.12	0.40	0.000230	0.12	-0.50	-0.000287	-0.14
350	3.10	0.001782	0.89	0.80	0.000460	0.23	0.50	0.000287	0.14	-0.60	-0.000345	-0.17
360	3.30	0.001897	0.95	0.80	0.000460	0.23	0.60	0.000345	0.17	-0.80	-0.000460	-0.23

TABLE 15 (M)

	U(MAX),ACCELERATION			1/2U(MAX),ACCLERATION			1/2U(MAX),DECELERATION			U(ZERO)		
ANG	MV	PSI	CP	MV	PSI	CP	MV	PSI	CP	MV	PSI	CP
0	3.20	0.057600	1.00	0.80	0.014400	0.25	1.00	0.018000	0.31	-0.90	-0.016200	-0.28
10	2.50	0.045000	0.78	0.69	0.012420	0.21	0.70	0.012600	0.22	-0.80	-0.014400	-0.25
20	2.20	0.039600	0.68	-0.40	-0.007200	-0.12	1.00	0.018000	0.31	-1.00	-0.018000	-0.31
30	0.80	0.014400	0.25	-1.20	-0.021600	-0.37	0.60	0.010800	0.19	-0.90	-0.016200	-0.28
40	-2.60	-0.046800	-0.81	-1.20	-0.021600	-0.37	-2.00	-0.036000	-0.62	-2.10	-0.037800	-0.65
50	-3.30	-0.059400	-1.03	-3.30	-0.059400	-1.03	-3.30	-0.059400	-1.03	-2.40	-0.043200	-0.75
60	-6.10	-0.109800	-1.90	-5.50	-0.099000	-1.71	-5.70	-0.102600	-1.77	-3.60	-0.064800	-1.12
70	-8.80	-0.158400	-2.74	-6.40	-0.115200	-1.99	-6.10	-0.109800	-1.90	-4.40	-0.079200	-1.37
80	-9.00	-0.162000	-2.80	-6.80	-0.122400	-2.12	-7.20	-0.129600	-2.24	-4.70	-0.084600	-1.46
90	-8.70	-0.156600	-2.71	-6.50	-0.117000	-2.02	-5.20	-0.093600	-1.62	-4.50	-0.081000	-1.40
100	-6.80	-0.122400	-2.12	-6.00	-0.108000	-1.87	-5.30	-0.095400	-1.65	-3.50	-0.063000	-1.09
110	-6.50	-0.117000	-2.02	-5.80	-0.104400	-1.81	-4.40	-0.079200	-1.37	-3.30	-0.059400	-1.03
120	-6.60	-0.118800	-2.05	-4.00	-0.072000	-1.25	-3.70	-0.066600	-1.15	-2.90	-0.052200	-0.90
130	-5.60	-0.100800	-1.74	-3.80	-0.068400	-1.18	-4.00	-0.072000	-1.25	-2.70	-0.048600	-0.84
140	-5.30	-0.095400	-1.65	-4.00	-0.072000	-1.25	-4.40	-0.079200	-1.37	-2.90	-0.052200	-0.90
150	-5.10	-0.091800	-1.59	-3.20	-0.057600	-1.00	-3.60	-0.064800	-1.12	-2.00	-0.036000	-0.62
160	-5.40	-0.097200	-1.68	-3.10	-0.055800	-0.96	-2.70	-0.048600	-0.84	-1.30	-0.023400	-0.40
170	-4.60	-0.082800	-1.43	-2.80	-0.050400	-0.87	-2.60	-0.046800	-0.81	-1.20	-0.021600	-0.37
180	-4.40	-0.079200	-1.37	-2.70	-0.048600	-0.84	-2.30	-0.041400	-0.72	-0.50	-0.009000	-0.16
190	-4.60	-0.082800	-1.43	-3.00	-0.054000	-0.93	-2.70	-0.048600	-0.84	-0.80	-0.014400	-0.25
200	-5.30	-0.095400	-1.65	-3.20	-0.057600	-1.00	-2.80	-0.050400	-0.87	-1.00	-0.018000	-0.31
210	-4.90	-0.088200	-1.53	-2.90	-0.052200	-0.90	-4.40	-0.079200	-1.37	-2.30	-0.041400	-0.72
220	-5.40	-0.097200	-1.68	-4.00	-0.072000	-1.25	-4.10	-0.073800	-1.28	-3.00	-0.054000	-0.93
230	-5.80	-0.104400	-1.81	-5.00	-0.090000	-1.56	-4.90	-0.088200	-1.53	-3.00	-0.054000	-0.93
240	-6.50	-0.117000	-2.02	-5.60	-0.100800	-1.74	-5.50	-0.099000	-1.71	-3.30	-0.059400	-1.03
250	-6.70	-0.120600	-2.09	-5.80	-0.104400	-1.81	-5.20	-0.093600	-1.62	-3.20	-0.057600	-1.00
260	-6.80	-0.122400	-2.12	-6.10	-0.109800	-1.90	-5.20	-0.093600	-1.62	-3.20	-0.057600	-1.00
270	-8.40	-0.151200	-2.61	-6.80	-0.122400	-2.12	-5.40	-0.097200	-1.68	-4.80	-0.086400	-1.49
280	-9.30	-0.167400	-2.89	-7.10	-0.127800	-2.21	-6.10	-0.109800	-1.90	-4.00	-0.072000	-1.25
290	-9.50	-0.171000	-2.96	-5.70	-0.102600	-1.77	-7.10	-0.127800	-2.21	-3.00	-0.054000	-0.93
300	-6.20	-0.111600	-1.93	-4.80	-0.086400	-1.49	-5.80	-0.104400	-1.81	-3.20	-0.057600	-1.00
310	-3.80	-0.068400	-1.18	-2.40	-0.043200	-0.75	-2.60	-0.046800	-0.81	-2.10	-0.037800	-0.65
320	-2.40	-0.043200	-0.75	-1.50	-0.027000	-0.47	-1.60	-0.028800	-0.50	-1.80	-0.032400	-0.56
330	-0.50	-0.009000	-0.16	-1.40	-0.025200	-0.44	-0.90	-0.016200	-0.28	-1.70	-0.030600	-0.53
340	1.70	0.030600	0.53	0.10	0.001800	0.03	0.0	0.0	0.0	-1.50	-0.027000	-0.47
350	2.40	0.043200	0.75	0.70	0.012600	0.22	0.80	0.014400	0.25	-0.90	-0.016200	-0.28
360	3.20	0.057600	1.00	0.80	0.014400	0.25	1.00	0.018000	0.31	-1.00	-0.018000	-0.31

TABLE 16 (N)

ANG	U(MAX),ACCELERATION MV	PSI	CP	1/2U(MAX),ACCLERATION MV	PSI	CP	1/2U(MAX),DECELERATION MV	PSI	CP	U(ZERO) MV	PSI	CP
0	1.60	0.028800	1.00	0.60	0.010800	0.38	0.60	-0.010800	0.38	0.0	0.0	0.0
10	1.20	0.021600	0.75	0.50	0.009000	0.31	0.40	0.007200	0.25	-0.20	-0.003600	-0.13
20	0.80	0.014400	0.50	-0.50	-0.009000	-0.31	0.0	0.0	0.0	-1.00	-0.018000	-0.63
30	1.60	0.028800	1.00	-0.40	-0.007200	-0.25	0.10	0.001800	0.06	0.20	0.003600	0.13
40	-1.10	-0.019800	-0.69	-2.10	-0.037800	-1.31	-1.40	-0.025200	-0.88	-1.80	-0.032400	-1.13
50	-1.50	-0.027000	-0.94	-1.70	-0.030600	-1.06	-1.90	-0.034200	-1.19	-1.90	-0.034200	-1.19
60	-2.50	-0.045000	-1.56	-2.10	-0.037800	-1.31	-2.70	-0.048600	-1.69	-1.80	-0.032400	-1.13
70	-3.70	-0.066600	-2.31	-3.00	-0.054000	-1.88	-2.80	-0.050400	-1.75	-1.80	-0.032400	-1.13
80	-4.60	-0.082800	-2.88	-3.30	-0.059400	-2.06	-3.00	-0.054000	-1.88	-1.90	-0.034200	-1.19
90	-4.70	-0.084600	-2.94	-3.10	-0.055800	-1.94	-2.80	-0.050400	-1.75	-1.90	-0.034200	-1.19
100	-4.00	-0.072000	-2.50	-2.80	-0.050400	-1.75	-2.10	-0.037800	-1.31	-2.00	-0.036000	-1.25
110	-3.00	-0.054000	-1.88	-2.80	-0.050400	-1.75	-2.10	-0.037800	-1.31	-2.00	-0.036000	-1.25
120	-3.00	-0.054000	-1.88	-1.60	-0.028800	-1.00	-1.60	-0.028800	-1.00	-0.90	-0.016200	-0.56
130	-3.30	-0.059400	-2.06	-2.00	-0.036000	-1.25	-1.50	-0.027000	-0.94	-1.00	-0.018000	-0.63
140	-3.20	-0.057600	-2.00	-2.80	-0.050400	-1.75	-1.50	-0.027000	-0.94	-0.80	-0.014400	-0.50
150	-2.10	-0.037800	-1.31	-0.70	-0.012600	-0.44	-1.50	-0.027000	-0.94	-0.80	-0.014400	-0.50
160	-4.00	-0.072000	-2.50	-0.70	-0.012600	-0.44	-1.20	-0.021600	-0.75	-0.60	-0.010800	-0.38
170	-1.30	-0.023400	-0.81	-0.80	-0.014400	-0.50	-1.10	-0.019800	-0.69	-0.30	-0.005400	-0.19
180	-0.90	-0.016200	-0.56	-0.70	-0.012600	-0.44	-0.40	-0.007200	-0.25	0.0	0.0	0.0
190	-1.40	-0.025200	-0.88	-0.80	-0.014400	-0.50	-0.20	-0.003600	-0.13	-0.20	-0.003600	-0.13
200	-1.30	-0.023400	-0.81	-2.00	-0.036000	-1.25	-1.20	-0.021600	-0.75	-0.60	-0.010800	-0.38
210	-2.70	-0.048600	-1.69	-2.40	-0.043200	-1.50	-1.10	-0.019800	-0.69	-0.90	-0.016200	-0.56
220	-1.80	-0.032400	-1.13	-0.60	-0.010800	-0.38	-1.10	-0.019800	-0.69	-0.80	-0.014400	-0.50
230	-1.50	-0.027000	-0.94	-1.10	-0.019800	-0.69	-1.10	-0.019800	-0.69	-0.70	-0.012600	-0.44
240	-3.00	-0.054000	-1.88	-2.00	-0.036000	-1.25	-1.10	-0.019800	-0.69	-1.10	-0.019800	-0.69
250	-2.70	-0.048600	-1.69	-0.90	-0.016200	-0.56	-1.20	-0.021600	-0.75	-0.60	-0.010800	-0.38
260	-4.00	-0.072000	-2.50	-1.70	-0.030600	-1.06	-1.20	-0.021600	-0.75	-0.90	-0.016200	-0.56
270	-4.60	-0.082800	-2.88	-3.80	-0.068400	-2.38	-2.30	-0.041400	-1.44	-1.40	-0.025200	-0.88
280	-3.90	-0.070200	-2.44	-3.30	-0.059400	-2.06	-2.50	-0.045000	-1.56	-1.40	-0.025200	-0.88
290	-3.50	-0.063000	-2.19	-2.50	-0.045000	-1.56	-2.30	-0.041400	-1.44	-1.40	-0.025200	-0.88
300	-4.00	-0.072000	-2.50	-2.00	-0.036000	-1.25	-1.20	-0.021600	-0.75	-1.00	-0.018000	-0.63
310	-1.30	-0.023400	-0.81	-1.70	-0.030600	-1.06	-1.30	-0.023400	-0.81	-1.20	-0.021600	-0.75
320	-0.20	-0.003600	-0.13	-1.20	-0.021600	-0.75	-0.60	-0.010800	-0.38	-0.60	-0.010800	-0.38
330	0.10	0.001800	0.06	-0.40	-0.007200	-0.25	0.0	0.0	0.0	-0.60	-0.010800	-0.38
340	0.80	0.014400	0.50	0.70	0.012600	0.44	0.0	0.0	0.0	1.10	0.019800	0.69
350	1.40	0.025200	0.88	0.40	0.007200	0.25	0.40	0.007200	0.25	0.20	0.003600	0.13
360	1.50	0.027000	0.94	0.50	0.009000	0.31	0.60	0.010800	0.38	0.0	0.0	0.0

TABLE 17 (0)

	U(MAX),ACCELERATION			1/2U(MAX),ACCLERATION			1/2U(MAX),DECELERATION			U(ZERO)		
ANG	MV	PSI	CP	MV	PSI	CP	MV	PSI	CP	MV	PSI	CP
0	6.10	0.007015	0.99	1.70	0.001955	0.28	1.20	0.001380	0.19	-1.10	-0.001265	-0.18
10	4.50	0.005175	0.73	1.20	0.001380	0.19	0.30	0.000345	0.05	-0.50	-0.000575	-0.08
20	1.10	0.001265	0.18	-1.00	-0.001150	-0.16	-0.70	-0.000805	-0.11	-0.50	-0.000575	-0.08
30	-3.00	-0.003450	-0.49	-2.60	-0.002990	-0.42	-1.50	-0.001725	-0.24	-0.70	-0.000805	-0.11
40	-7.20	-0.008280	-1.17	-3.60	-0.004140	-0.58	-3.10	-0.003565	-0.50	-1.10	-0.001265	-0.18
50	-9.40	-0.010810	-1.53	-7.40	-0.008510	-1.20	-6.00	-0.006900	-0.97	-2.20	-0.002530	-0.36
60	-13.50	-0.015525	-2.19	-9.50	-0.010925	-1.54	-9.20	-0.010580	-1.49	-2.30	-0.002645	-0.37
70	-15.20	-0.017480	-2.47	-13.10	-0.015065	-2.13	-11.40	-0.013110	-1.85	-2.40	-0.002760	-0.39
80	-16.60	-0.019090	-2.70	-13.50	-0.015525	-2.19	-11.90	-0.013685	-1.93	-2.00	-0.002300	-0.32
90	-17.10	-0.019665	-2.78	-13.00	-0.014950	-2.11	-11.10	-0.012765	-1.80	-1.60	-0.001840	-0.26
100	-16.20	-0.018630	-2.63	-10.20	-0.011730	-1.66	-9.20	-0.010580	-1.49	-2.00	-0.002300	-0.32
110	-11.40	-0.013110	-1.85	-8.60	-0.009890	-1.40	-8.50	-0.009775	-1.38	-1.80	-0.002070	-0.29
120	-9.60	-0.011040	-1.56	-6.60	-0.007590	-1.07	-7.20	-0.008280	-1.17	-1.20	-0.001380	-0.19
130	-7.20	-0.008280	-1.17	-5.80	-0.006670	-0.94	-4.50	-0.005175	-0.73	-0.90	-0.001035	-0.15
140	-7.00	-0.008050	-1.14	-5.70	-0.006555	-0.93	-4.00	-0.004600	-0.65	-1.00	-0.001150	-0.16
150	-6.10	-0.007015	-0.99	-4.40	-0.005060	-0.71	-3.10	-0.003565	-0.50	-1.20	-0.001380	-0.19
160	-5.20	-0.005980	-0.84	-4.00	-0.004600	-0.65	-2.60	-0.002990	-0.42	-0.30	-0.000345	-0.05
170	-5.30	-0.006095	-0.86	-3.80	-0.004370	-0.62	-2.40	-0.002760	-0.39	-0.20	-0.000230	-0.03
180	-5.20	-0.005980	-0.84	-3.80	-0.004370	-0.62	-2.10	-0.002415	-0.34	0.0	0.0	0.0
190	-5.30	-0.006095	-0.86	-3.80	-0.004370	-0.62	-2.00	-0.002300	-0.32	-0.20	-0.000230	-0.03
200	-5.10	-0.005865	-0.83	-3.60	-0.004140	-0.58	-2.40	-0.002760	-0.39	-0.30	-0.000345	-0.05
210	-5.90	-0.006785	-0.96	-4.10	-0.004715	-0.67	-2.90	-0.003335	-0.47	-0.80	-0.000920	-0.13
220	-7.00	-0.008050	-1.14	-5.30	-0.006095	-0.86	-4.00	-0.004600	-0.65	-1.00	-0.001150	-0.16
230	-7.60	-0.008740	-1.23	-5.60	-0.006440	-0.91	-4.50	-0.005175	-0.73	-0.70	-0.000805	-0.11
240	-9.60	-0.011040	-1.56	-6.40	-0.007360	-1.04	-6.80	-0.007820	-1.10	-0.80	-0.000920	-0.13
250	-11.60	-0.013340	-1.88	-8.40	-0.009660	-1.36	-8.50	-0.009775	-1.38	-2.00	-0.002300	-0.32
260	-16.00	-0.018400	-2.60	-9.80	-0.011270	-1.59	-8.80	-0.010120	-1.43	-2.00	-0.002300	-0.32
270	-16.90	-0.019435	-2.74	-13.00	-0.014950	-2.11	-10.90	-0.012535	-1.77	-1.80	-0.002070	-0.29
280	-17.00	-0.019550	-2.76	-13.50	-0.015525	-2.19	-11.90	-0.013685	-1.93	-2.00	-0.002300	-0.32
290	-14.80	-0.017020	-2.40	-12.90	-0.014835	-2.09	-11.40	-0.013110	-1.85	-2.60	-0.002990	-0.42
300	-13.50	-0.015525	-2.19	-9.50	-0.010925	-1.54	-8.80	-0.010120	-1.43	-2.70	-0.003105	-0.44
310	-9.60	-0.011040	-1.56	-7.20	-0.008280	-1.17	-6.00	-0.006900	-0.97	-2.20	-0.002530	-0.36
320	-6.80	-0.007820	-1.10	-3.60	-0.004140	-0.58	-2.90	-0.003335	-0.47	-0.90	-0.001035	-0.15
330	-3.00	-0.003450	-0.49	-2.40	-0.002760	-0.39	-1.50	-0.001725	-0.24	-0.50	-0.000575	-0.08
340	0.90	0.001035	0.15	-1.00	-0.001150	-0.16	-0.50	-0.000575	-0.08	-0.50	-0.000575	-0.08
350	4.50	0.005175	0.73	0.80	0.000920	0.13	0.10	0.000115	0.02	-0.70	-0.000805	-0.11
360	6.10	0.007015	0.99	1.30	0.001495	0.21	0.80	0.000920	0.13	-0.90	-0.001035	-0.15

TABLE 18 (P)

	U(MAX),ACCELERATION			1/2U(MAX),ACCLERATION			1/2U(MAX),DECELERATION			U(ZERO)		
ANG	MV	PSI	CP	MV	PSI	CP	MV	PSI	CP	MV	PSI	CP
0	3.20	0.001840	1.04	1.00	0.000575	0.32	0.60	0.000345	0.19	-0.20	-0.000115	-0.06
10	2.70	0.001552	0.88	0.90	0.000517	0.29	0.40	0.000230	0.13	-0.10	-0.000057	-0.03
20	1.60	0.000920	0.52	0.20	0.000115	0.06	0.20	0.000115	0.06	0.10	0.000057	0.03
30	-1.20	-0.000690	-0.39	-1.00	-0.000575	-0.32	-0.50	-0.000287	-0.16	0.0	0.0	0.0
40	-3.70	-0.002127	-1.20	-1.70	-0.000977	-0.55	-1.10	-0.000632	-0.36	-0.30	-0.000172	-0.10
50	-6.20	-0.003565	-2.01	-4.30	-0.002472	-1.40	-3.00	-0.001725	-0.97	-0.50	-0.000287	-0.16
60	-7.20	-0.004140	-2.34	-5.20	-0.002990	-1.69	-4.00	-0.002300	-1.30	-0.60	-0.000345	-0.19
70	-8.00	-0.004600	-2.60	-5.50	-0.003162	-1.79	-4.50	-0.002587	-1.46	-0.50	-0.000287	-0.16
80	-7.80	-0.004485	-2.53	-5.20	-0.002990	-1.69	-4.20	-0.002415	-1.36	-0.50	-0.000287	-0.16
90	-6.40	-0.003680	-2.08	-4.10	-0.002357	-1.33	-3.20	-0.001840	-1.04	-0.40	-0.000230	-0.13
100	-5.40	-0.003105	-1.75	-3.20	-0.001840	-1.04	-2.90	-0.001667	-0.94	-0.30	-0.000172	-0.10
110	-3.80	-0.002185	-1.23	-3.10	-0.001782	-1.01	-2.50	-0.001437	-0.81	-0.50	-0.000287	-0.16
120	-3.70	-0.002127	-1.20	-3.20	-0.001840	-1.04	-2.60	-0.001495	-0.84	-0.50	-0.000287	-0.16
130	-3.40	-0.001955	-1.10	-2.80	-0.001610	-0.91	-2.30	-0.001322	-0.75	-0.40	-0.000230	-0.13
140	-3.60	-0.002070	-1.17	-2.90	-0.001667	-0.94	-2.50	-0.001437	-0.81	-0.30	-0.000172	-0.10
150	-3.50	-0.002012	-1.14	-3.00	-0.001725	-0.97	-2.60	-0.001495	-0.84	-0.10	-0.000057	-0.03
160	-3.30	-0.001897	-1.07	-2.70	-0.001552	-0.88	-2.30	-0.001322	-0.75	0.10	0.000057	0.03
170	-3.20	-0.001840	-1.04	-2.80	-0.001610	-0.91	-2.20	-0.001265	-0.71	0.40	0.000230	0.13
180	-3.20	-0.001840	-1.04	-2.70	-0.001552	-0.88	-1.90	-0.001092	-0.62	-0.30	-0.000172	-0.10
190	-3.30	-0.001897	-1.07	-2.60	-0.001495	-0.84	-2.00	-0.001150	-0.65	0.20	0.000115	0.06
200	-3.40	-0.001955	-1.10	-2.70	-0.001552	-0.88	-2.20	-0.001265	-0.71	0.10	0.000057	0.03
210	-3.50	-0.002012	-1.14	-2.80	-0.001610	-0.91	-2.40	-0.001380	-0.78	0.10	0.000057	0.03
220	-3.60	-0.002070	-1.17	-2.70	-0.001552	-0.88	-2.30	-0.001322	-0.75	-0.10	-0.000057	-0.03
230	-3.50	-0.002012	-1.14	-2.80	-0.001610	-0.91	-2.40	-0.001380	-0.78	-0.40	-0.000230	-0.13
240	-3.50	-0.002012	-1.14	-2.80	-0.001610	-0.91	-2.40	-0.001380	-0.78	-0.40	-0.000230	-0.13
250	-3.80	-0.002185	-1.23	-3.10	-0.001782	-1.01	-2.50	-0.001437	-0.81	-0.30	-0.000172	-0.10
260	-5.60	-0.003220	-1.82	-3.20	-0.001840	-1.04	-2.50	-0.001437	-0.81	-0.10	-0.000057	-0.03
270	-6.60	-0.003795	-2.14	-3.90	-0.002242	-1.27	-3.20	-0.001840	-1.04	-0.40	-0.000230	-0.13
280	-7.80	-0.004485	-2.53	-5.00	-0.002875	-1.62	-3.80	-0.002185	-1.23	-0.60	-0.000345	-0.19
290	-7.80	-0.004485	-2.53	-5.50	-0.003162	-1.79	-4.50	-0.002587	-1.46	-0.60	-0.000345	-0.19
300	-6.80	-0.003910	-2.21	-5.20	-0.002990	-1.69	-4.00	-0.002300	-1.30	-0.60	-0.000345	-0.19
310	-5.80	-0.003335	-1.88	-3.90	-0.002242	-1.27	-3.00	-0.001725	-0.97	-0.50	-0.000287	-0.16
320	-3.70	-0.002127	-1.20	-1.90	-0.001092	-0.62	-1.30	-0.000747	-0.42	-0.50	-0.000287	-0.16
330	-1.40	-0.000805	-0.45	-0.80	-0.000460	-0.26	-0.70	-0.000402	-0.23	0.0	0.0	0.0
340	1.40	0.000805	0.45	0.0	0.0	0.0	0.0	0.0	0.0	0.10	0.000057	0.03
350	2.50	0.001437	0.81	0.70	0.000402	0.23	0.60	0.000345	0.19	0.10	0.000057	0.03
360	3.00	0.001725	0.97	0.60	0.000345	0.19	0.60	0.000345	0.19	-0.20	-0.000115	-0.06

TABLE 19

COMPUTER PROGRAM

```
      DIMENSION S(10,4),SPCOS(10),FPERL(4),FTOTAL(4)
      DIMENSION PSI(37,4),ANG(37),CP(37,4),PCOS(37,4),NAG(37),MV(37,4)
      DIMENSION ICH(4),IKX(6),IKY(6),MVV(37,4),Q(37,4)
      DIMENSION PPSI(37,4),P(37,4)
      DIMENSION CCP(37,4),CC(37,4),IDY(6)
      DIMENSION MV1(19,4),MV11(19,4),CP1(19,4),CP11(19,4)
      DIMENSION QQ(19,4),CCC(19,4)
      DIMENSION SP(4)
      EQUIVALENCE(MV11,MV1),(CP11,CP1)
      EQUIVALENCE(MVV,MV),(PPSI,PSI),(CCP,CP)
      DATA IKX/'ANGL','E  I','N  D','EGRE','ES  ','    '/
      DATA IKY/'PSI.','    ','    ','    ','    ','    '/
      DATA IDY/'PRES','SURE',' COE','FFIC','IENT','  CP'/
      DATA ICH/'*','C','.','X'/
      REAL LENGTH,MV,MVV,MV1,MV11
    9 READ(5,7)N,LENGTH,D,PS,RO,A,W
    7 FORMAT(I2,6F10.3)
      IF(N .EQ. 0)STOP
      DO 8 J=1,4
      READ(5,88)(S(K,J),K=1,10),(MV(I,J),I=1,37)
   88 FORMAT(10A1,/(16F5.2))
    8 CONTINUE
      VMAX = A*W*2.*3.14159/60.0
      SPCOS(1)=0.
      SPCOS(2)=0.
      SPCOS(3)=0.
      SPCOS(4)=0.
      ANG(1) =0.
      DO 11 J = 1,36
      JJ = J+1
      ANG(JJ)=ANG(J)+10.0
   11 CONTINUE
      DO 20 J=1,4
      DO 20 I = 1,37
      GO TO (101,101,101,101,105,105,101,101,109,110,111,111,113,113,
     1115,116),N
  101 PSI(I,J)=MV(I,J)*0.018/40.0
      GO TO 12
  105 PSI(I,J)=MV(I,J)*0.018/20.0
```

```
      GO TO 12
  109 PSI(I,J)=MV(I,J)*0.018/4.0
      GO TO 12
  110 PSI(I,J)=MV(I,J)*0.018/8.0
      GO TO 12
  111 PSI(I,J)=MV(I,J)*0.023/40.0
      GO TO 12
  113 PSI(I,J)=MV(I,J)*0.018
      GO TO 12
  115 PSI(I,J)=MV(I,J)*0.023/20.0
      GO TO 12
  116 PSI(I,J)=MV(I,J)*0.023/40.0
   12 X=ANG(I)*3.14159/180.
      PCOS(I,J)=PSI(I,J)*COS(X)
      IF(I .GT. 36)GO TO 19
      SPCOS(J)=SPCOS(J)+PCOS(I,J)
   19 CP(I,J)=2.*(12.**4.)*PSI(I,J)/RO/(VMAX**2.)
   20 CONTINUE
      WRITE(6,18)((S(K,J),K=1,10),J=1,4)
   18 FORMAT(///,1X,125(1H*),//,13X,10A1,21X,10A1,21X,10A1,21X,10A1,
     1//,1X,125(1H*))
   21 WRITE(6,30)D,LENGTH,A,PS,RO,W
   30 FORMAT(////,11X,'DIAM D  = ',F5.2,3X,'IN.',
     1/,11X,'CYLD L  = ',F5.2,3X,'IN.',
     2/,11X,'AMPL A  = ',F5.2,3X,'IN.',
     3/,11X,'STP PS  = ',F5.2,3X,'PSI.',
     4/,11X,'DEN RO  = ',F5.2,3X,'SLUG/FT**3',
     5/,11X,'SPEED   = ',F5.2,3X,'RPM')
      WRITE(6,290)
  290 FORMAT(1H1,97(1H*),/6X,'U(MAX),ACCELERATION',2X,'*',
     11X,'1/2U(MAX),ACCLERATION *',1X,'1/2U(MAX),DECELERATICN*',
     28X,'U(ZERO)',
     3/,1X,'ANG',3X,'MV',6X,'PSI',5X,'CP',2X,'*',3X,'MV',6X,'PSI',5X,
     4'CP',2X,'*',3X,'MV',6X,'PSI',5X,'CP',2X,'*',3X,'MV',6X,'PSI',5X,
     5'CP',/98(1H*))
      DO 300 I =1,37
      NAG(I)=ANG(I)
  300 WRITE(6,31)NAG(I),MV(I,1),PSI(I,1),CP(I,1),
     1MV(I,2),PSI(I,2),CP(I,2),MV(I,3),PSI(I,3),
     2CP(I,3),MV(I,4),PSI(I,4),CP(I,4)
```

```
   31 FORMAT(1X,I3,3(F6.2,1X,F9.6,1X,F5.2,2H *),F6.2,1X,F9.6,1X,F5.2)
      ACCMAX=A*(W*2.*3.14159/60.)**2
      WRITE(6,41)VMAX,ACCMAX
   41 FORMAT(1X,97(1H*),///,11X,'VMAX     =',F5.2,/,11X,'ACCMAX  =',F6.2
     1)
      DO 400 J = 1,4
      DO 400 I = 1,19
      K = 38-I
      MV1(I,J)=0.5*(MV(I,J)+MV(K,J))
      CP1(I,J)=0.5*(CP(I,J)+CP(K,J))
  400 CONTINUE
      DO 40 J =1,4
      FPERL(J)=.5*D*SPCOS(J)*10.*3.14159/180.0
      FTOTAL(J)=FPERL(J)*LENGTH
      WRITE(6,51)J,FPERL(J),J,FTOTAL(J),J,SPCOS(J)
   40 CONTINUE
   51 FORMAT(/,11X,'FPERL(',I1,')=',F7.4,5X,'FTOTAL(',I1,')=',F7.4,5X,
     1'SPCOS(',I1,')=',F7.3)
      SP(1)=0.
      SP(2)=0.
      SP(3)=0.
      SP(4)=0.
      DO 2 J = 1,4
      DO 1 I1 = 1,31,6
      I2=I1+1
      I3=I1+2
      I4=I1+3
      I5=I1+4
      I6=I1+5
      I7=I1+6
      SP(J)=SP(J)+PCOS(I1,J)+5*PCOS(I2,J)+PCOS(I3,J)+6*PCOS(I4,J)
     1+PCOS(I5,J)+5*PCOS(I6,J)+PCOS(I7,J)
    1 CONTINUE
      FPERL(J)=.5*D*10.*3.14159/180.0*3.0/10.0*SP(J)
      FTOTAL(J)=FPERL(J)*LENGTH
      WRITE(6,51)J,FPERL(J),J,FTOTAL(J),J,SP(J)
    2 CONTINUE
      CALL PLOTR2(ANG,MVV,0,37,4,37,4,0.0,360.0,0.0,0.0,
     1ICH,IKX,IKY,0.0,0.0,1)
```

```
0101      CALL PLOTR2(ANG,PPSI,P,37,4,37,4,0.0,360.0,0.0,0.0,
         1ICH,IKX,IKY,0.0,0.0,1)
0102      CALL PLOTR2(ANG,CCP,CC,37,4,37,4,0.0,360.0,0.0,0.0,
         1ICH,IKX,IDY,0.0,0.0,1)
0103      CALL PLOTR2(ANG,MV11,QQ,19,4,19,4,0.0,360.0,0.0,0.0,
         1ICH,IKX,IKY,0.0,0.0,1)
0104      CALL PLOTR2(ANG,CP11,CCC,19,4,19,4,0.0,360.0,-3.50,1.50,
         1ICH,IKX,IDY,0.0,0.0,1)
0105      GO TO 9
0106      END
```