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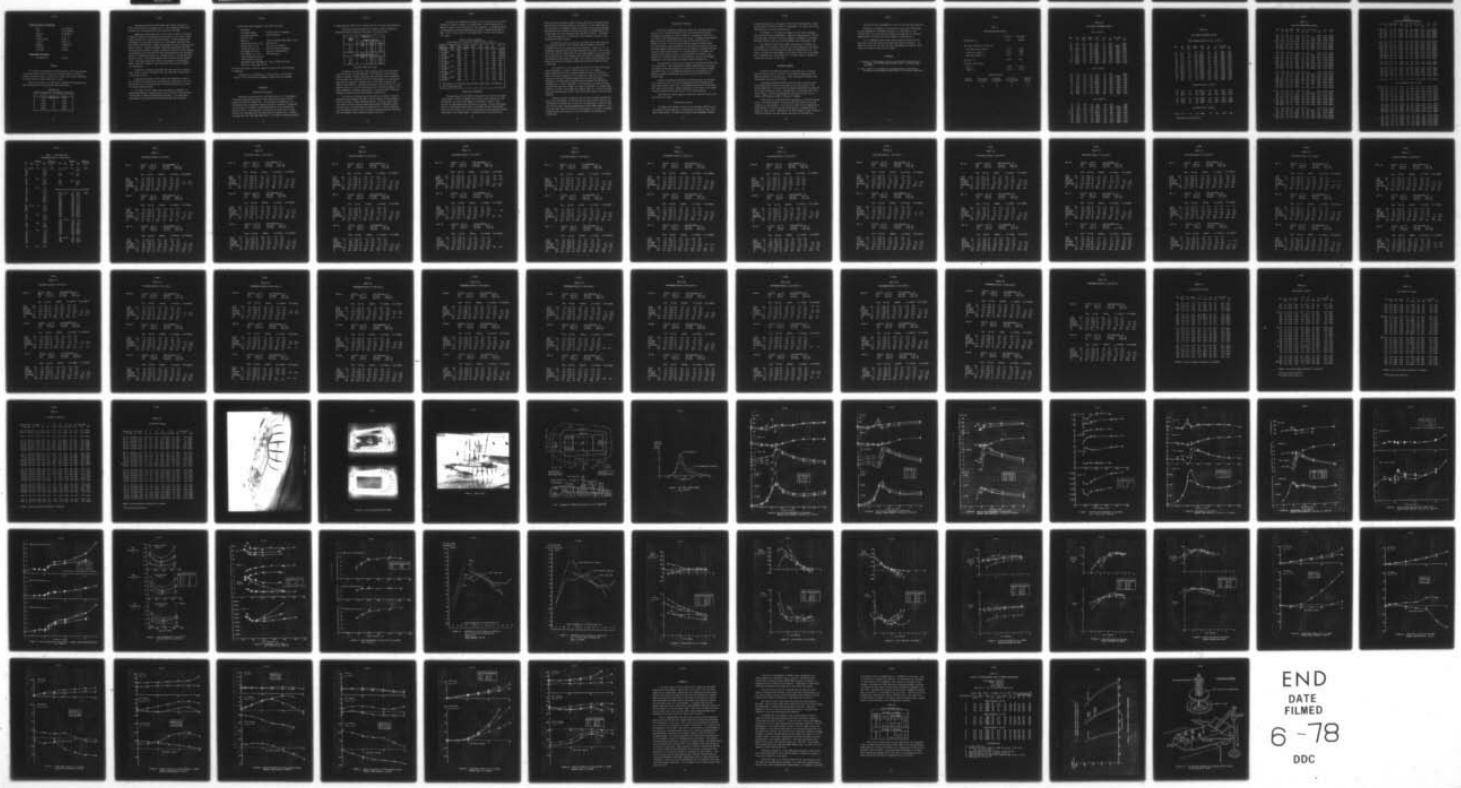

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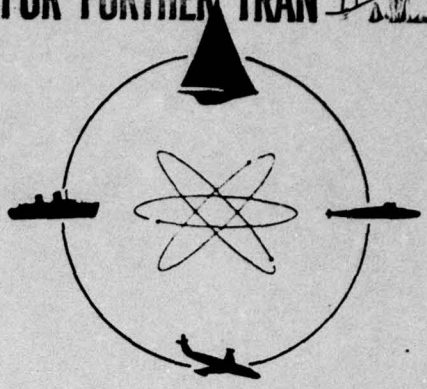

DAVIDSON LABORATORY

REPORT SIT-DL-76-1921
December 1976

FSACV MODEL DEVELOPMENT TESTS CALM AND ROUGH WATER PERFORMANCE AND STABILITY CHARACTERISTICS

by
R.L. Van Dyck

Prepared for
Code 03221 of Naval Sea Systems Command
under
Office of Naval Research Contract
N00014-76-C-1031
Project No. NR-062-557
(Davidson Laboratory Project 4427/197)

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Hydrodynamic tests were conducted on a model of the FSACV to characterize the craft in the areas of performance, seakeeping, habitability and stability. Data was obtained over a range of LCG's, trunk pressures, speeds, and cushion air flows in both calm water and irregular head seas. The results are tabulated and graphed, and the effect of major parameters discussed.

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P. Ward Brown, Manager
Marine Craft Development Group

NOMENCLATURE

DRAG	drag force in wind axis, lb
EQV DRAG	total of drag plus cushion fan drag, lb
FAN DRAG	cushion fan power required/velocity, expressed as a force, lb
HEAVE	height of CG tow pivot above still water level, ft
K	roll moment in body axis, positive starboard side down, ft-lb
M	pitching moment in body axis, positive bow up, ft-lb
N	yaw moment in body axis, positive bow to starboard, ft-lb
PC	cushion pressure, psf
PT	trunk pressure, psf
Q	cushion air flow, cfs
V, VEL	forward velocity, fps
X	drag force in body axis, positive aft, lb
Y	side force in body axis, positive to starboard, lb
Yaw	yaw angle, positive bow to starboard, degrees
Pitch, trim	angle of wet deck hard bottom from horizontal, positive bow up, degrees
LCG	longitudinal location of center of gravity, ft
VCG	vertical location of center of gravity, ft

Note: The body-axis system and sign convention used is the conventional right-handed system adopted for submerged bodies, with the x-axis directed forward, the y-axis to starboard, and the z-axis down. For convenience the negative sign of the drag forces has been omitted.

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INTRODUCTION

Calm water performance and stability together with tests in irregular head seas were conducted on a hydrodynamic model of a "full-scale air cushion vehicle" (FSACV) in order to provide data and to identify possible problem areas toward the design of a full scale test vehicle to validate the ACV-LVA concept. This report presents results directed toward characterizing the craft without tracks in the areas of performance, seakeeping, habitability and stability.

All tests were run free-to-heave and either fixed or free-to-trim at constant speed in the Davidson Laboratory's high speed towing facility. Primary test parameters examined were LCG, trunk pressure, velocity and cushion air flow. All quantities and model particulars, unless otherwise noted, are presented full scale.

The tests were performed during the period September 1976 through January 1977 in support of a development program initiated by Code 03221 of the Naval Sea Systems Command. Technical monitoring was provided by the LVA Technical Management Office, David Taylor Naval Ship Research and Development Center (DTNSRDC).

MODEL

The basic 1/9-scale model, constructed by the Davidson Laboratory, was comprised of a peripheral trunk, supplied by DTNSRDC, fitted to a light-weight plexiglass centerbody complete with trunk inflation and lift fan system compatible with the Davidson Laboratory towing tank support equipment; see Figures 1 through 4. The fan characteristics simulated in these tests duplicated the pressure-flow curve selected by the LVA Office, which specified a design cushion air flow rate of 1150 cfs and cushion pressure of 112 psf. A nominal design trunk pressure equivalent to 200 psf was used for the baseline configuration.

The model fan systems were comprised of Rotron Aximax 3, 200 volt, 400 Hz, 3 phase, 22,000 rpm vaneaxial fans. Four such fans were mounted in a bow plenum chamber which directed air into the forward cushion through an 11.64 ft^2 full size opening. Flow rates were adjusted by switching on various whole fans or by partially choking the inlets to the fans. The trunk was inflated by two stacked fans mounted on the stern capable of producing a no-flow trunk pressure of approximately 450 psf full size. This pressure was adjusted by means of a variable area opening in the bow which vented the flow to the atmosphere and/or by switching off one of the two stacked fans. The specified design pressure-flow curve for the cushion fan, together with the scaled-up model fan characteristics, are included in the Appendix.

Because of the hard ride experienced by the model, later tests were conducted with pressure relief valves installed in the trunk and cushion. In addition, a flat-plate hydrofoil (Area = 13.7 ft^2 full scale and aspect ratio = 4) was attached to the undersides of the wet deck as a means to also reduce the impact loads. Further descriptions of these tests are contained in the Appendix.

The model was towed through a pitch pivot located at a nominal center of gravity equivalent to 12.84 ft forward of the transom and 3.075 ft above the wet deck (see Figure 4). Ballast weights were located in the model for setting and adjusting the LCG. The pitch radius of gyration was measured as 8.21 ft (full scale) for the rough water test configuration.

Leading particulars are summarized in Table 1 and Figure 4.

APPARATUS AND INSTRUMENTATION

The model tests were carried out in Davidson Laboratory's Tank 3 test facility. The test set-up and model are shown in Figure 3. The performance test setup allows the model freedom in pitch and heave, with restraint in yaw, roll and sway. Test instrumentation included a 50 lb capacity drag balance, heave and pitch transducers to measure the motions

at and about the pitch axis, located at the nominal model LCG, and bow, CG, and stern accelerometers located as shown in Figure 4. In rough water, a wave strut attached to the towing carriage was mounted to record the wave encounters. Pressures were measured in the cushion and the trunk for all test runs using Setra Model 237 differential gages mounted on the model as shown in the figures and referenced to ambient conditions by a static pressure tube running in undisturbed air ahead of the model carriage.

The stability test setup allows the model freedom in heave, with restraint in trim as well as yaw, roll and sway using a five component balance substituted for the single component drag balance of the performance tests. A pivoted unloading arm was used to unload the extra mass of the larger balance. Measurements were made of drag, side force, yawing moment, rolling moment and pitching moment.

The signals from the transducers were filtered (40-Hz low pass), recorded on analog magnetic tape for the rough water tests and processed by an on-line PDP-8e computer, which includes an analog-to-digital converter. The model results were printed on a teletype and also stored on digital magnetic tape. All data channels were monitored on an oscillograph. A camera carriage, mounted ahead of the main carriage, included a black and white television camera and a still overwater picture camera to observe the model underway. In addition to monitoring the model by closed-circuit TV, a video-tape recording was made of each run. Underwater pictures were also taken of most smooth water tests.

For the rough water tests, the Tank 3 plunger-type wave maker was used to make irregular waves equivalent to a Sea State 2. The irregular waves generated are a reproducible set of 100 waves having a variance density approximating the Pierson-Moskowitz spectrum. The spectrum used in these tests had a significant wave height of 2.2 ft and is compared with the Pierson-Moskowitz spectrum in Figure 5; see also Table 1.

DATA PROCESSING

The instrumentation was calibrated by applying known displacements to the motion transducers and wave strut, known loads and moments to the balances, gravity multiples to the accelerometers and known pressures to the pressure transducers. Calibrations were recorded either directly or on analog magnetic tape and processed by the on-line computer. All calibrations were linear and a "least-squares" technique was used to determine the calibration rates, which were spot-checked daily.

The results were computed from the differences between the transducer outputs in the zero and running conditions. Performance test drag zeros were taken with the model floating on the water in calm conditions, twice a day, and stored in the computer; the floating drag zero was monitored for stability between runs. All other zeros, including drag zeros during fixed-trim stability tests, were taken with the model in the air at known trim and known elevation above the water surface. After the model was up to constant speed, data was collected over a designated section of the tank. During data collection all channels of information were scanned at a rate of 250 Hz and the results stored in the computer for appropriate processing.

Mean values of drag, trim, heave, and pressure were computed for calm water tests. The heave is defined as the height of the tow point pivot relative to calm water. The velocity was computed from the time taken to travel through the data-collection section of the tank.

For the irregular wave tests the velocity and mean drag were computed and a peak-trough analysis performed for the heave, pitch, acceleration and pressure channels. The peak-trough analysis computes for each signal the mean, rms, and statistics of the peaks and troughs (maxima and minima), including the average and average of the 1/3 and 1/10 highest values. In the statistical analysis, spurious oscillations are suppressed by means of "buffers." (Buffers are selected so as to prevent the detection of substantial maxima and minima in corresponding steady-state calm

water runs. A substantial maximum (minimum) is defined as any maximum (minimum) succeeded by a decrease (increase) in signal level at least equal to the magnitude of the stipulated buffer size.) Typical model scale buffers employed in these tests were 0.4 degree pitch, 0.3 inch heave, 0.4 g acceleration, and 4 psf pressure. In addition, for selected runs, spectral analysis of the vertical accelerations at the CG were performed and converted to 1/3-octave rms format for comparison with the habitability criteria.

The air flow was calculated from the fan characteristics and the measured pressure. Calibrations of the Aximax Type 3 fans[1] in a simulated plenum gave the following model scale expression for cushion air flow per fan in terms of the cushion pressure:

$$Q \times 10^{3} = 2486 - 30.19P + 0.5427P^{2} - 0.06805P^{3}$$

where

Q = air flow, cfs

P = cushion pressure, psf (also = PC)

The power delivered by the cushion fans was converted to an equivalent drag value which may be added to the hydrodynamic drag to give an overall measure of craft efficiency. The fan drag is defined as:

$$\text{Fan Drag} = \frac{1}{V} \Sigma N P Q$$

where

V = craft velocity, fps

N = number of fans delivering air to the cushion

Note: The air leakage from the trunk can be considered negligible and has not been included in the fan drag calculation.

The five-component force balance used in the stability tests remains horizontal at all times so that when zeros are taken with the model suspended from the balance it is not affected by angular orientation of the model. With this balance system, the forces and moments are measured in modified wind axes (the model rotates with the balance in yaw) and the following equations are used to obtain the forces and moments in body axes

from the measured forces and moments, the latter being denoted by primes:

$$X = X' \cos\theta$$

$$Y = Y' \cos\varphi - X' \sin\theta \sin\varphi$$

$$K = K' \cos\theta - N' \sin\theta$$

$$M = M' \cos\varphi + (N' \cos\theta + K' \sin\theta)\sin\varphi$$

$$N = (N' \cos\theta + K' \sin\theta)\cos\varphi - M' \sin\varphi$$

where

θ = trim angle

φ = roll angle

ψ = yaw angle

The hydrodynamic drag is the component of the resultant force parallel to the velocity vector and is calculated from

$$D_H = X' \cos\psi + Y' \sin\psi \ .$$

TEST PROGRAM

This exploratory test program was conducted in several series described below. Most tests were made free-to-heave at a displacement equivalent to 56,000 lb with tow pivots located at the nominal CG position listed in Table 1. Specific parametric test values may be found in the tables of results. Black-and-white video recordings were taken of all runs.

Calm Water Performance

Constant speed, free-to-trim tests were run at from 0 to 35 knots to determine operating characteristics at LCG's of 14.53, 13.78, 13.03, 12.78, and 12.28 ft aft of Bow Station 100 (12.84, 13.59, 14.34, 14.59, and 15.09 ft forward of transom) with nominal trunk pressures of 117, 150, and 220 psf. In addition, a range of trunk pressures of from 450 psf to as low as 80 psf were investigated at 11.7, 20 and 30 knots. Nominal cushion air flow rate of 1150 cfs was varied from 1700 to 700 cfs in the same speed range. Other conditions tested were a heavier

displacement of 58,200 lb and a series of runs at lighter loads to account for thrust unloading. Overwater bow quarter view and underwater bottom view color photographs were taken of these runs.

Rough Water Performance

Irregular waves having a 2.2 ft significant height and a Pierson-Moskowitz spectrum were used for the rough water sequence of tests at speeds up to 35 knots. Two basic LCG locations of 14.53 and 13.78 ft were tested at nominal trunk pressures of 120 and 220 psf throughout the speed range. In addition, a range of mean trunk pressures of from 305 to 80 psf were investigated at selected speeds that usually included "hump", 11.7 knots and 30 knots at a nominal cushion air flow rate of 1200 cfs. A higher nominal air flow rate of 1750 cfs was also tested at trunk pressures of 220, 155 and 95 psf.

Since the tests were exploratory in nature; a single run per test condition was made in the irregular train of waves. This limited the number of wave encounters to 75 at the 5 knot speed to 22 at 30 knots, as compared to the 100 waves available in the sea spectrum. All tests at a given speed were run in the same sample of waves; thus comparisons between configurations and other test parameters can be made.

Tests to attenuate the acceleration levels of the FSACV were made at 30 knots with certain configurational additions to the model. These consisted of various combinations of pressure relief valves in the trunk and cushion, and a hydrofoil mounted to the undersides of the wet deck at two longitudinal positions. In addition the model was run in reverse. Details of these tests are included in the Appendix.

Calm Water Pitch Stability

Fixed trim tests were conducted at constant speeds of 11.7, 20 and 30 knots at trunk pressures of 340, 220, 150 and 95 psf over the range of trim angles from -1 to +5 degrees.

Calm Water Directional Stability

Tests were conducted at constant speeds of 11.7, 20 and 30 knots at nominal trunk pressure of 220 psf at zero roll angle over a range of yaw angles up to 30 degrees at two fixed trim angles for each velocity. The trim angles were selected to bracket the region of optimum drag and included: 0.5 and 5.0 degrees for 11.7 knots, 2 and 4 degrees for 20 knots and 0.5 and 2.5 degrees for 30 knots. In addition, at 11.7 knots and 0.5 degree trim angle, trunk pressure variations were tested.

Drag Air Tares

Drag runs made with the trunk inflated at nominal trunk pressure for the model just above the water with all cushion fans off showed a full-scale tare of $0.44V^2$ lb, where V is velocity in knots. Based on the frontal area, this works out to be a drag coefficient (C_D) of 0.56. Cushion pressure was monitored for these tests and was found to equal the ambient condition.

PRECISION

The precision of the results is estimated to be within the following full-scale values:

Performance Tests -- Free Trim

Velocity		± .05 knot
Trim -	Calm Water	± .05 degree
	Waves	± .25 degree
Heave		± .1 ft
Drag		± 40 lb
Pressures		± 2 psf
Air Flow		± 20 cfs
LCG		± .01 ft

Stability Tests -- Fixed Trim

Yaw	± 0.2 degree
Trim	± 0.05 degree
Velocity	± 0.05 knot
Heave	± 0.1 ft
X-force, Drag	± 130 lb
Y-force	± 700 lb
Moments	± 6000 ft-lb
Pressures	± 2 psf
Air Flow	± 20 cfs

Rough Water Performance

Accelerations	± 0.05 g

RESULTS

All results are presented in prototype values; which were obtained by applying Froude scaling directly to the model results, including a fresh to salt water density correction of 1.027 on the forces and moments. All drag results are uncorrected for air tares.

Most results apply to a craft having a 56,000 lb displacement with the LCG locations aft of Bow Station 100 listed below:

Prototype LCG

Aft of Station 100 ft	Forward of Transom ft
14.53 - NOMINAL LCG -	12.84
13.78	13.59
13.03	14.34
12.78	14.59
12.28	15.09

Calm water free-to-trim performance test results are given in Table 2 and are shown in Figures 6 and 7. Test parameters were velocity (V), LCG, trunk pressure (PT) and cushion air flow (Q).

Rough water performance results are listed in Table 3 in order of increasing velocity, trunk pressure, LCG and cushion air flow for a Sea State 2 having 2.2 ft significant height waves. At those speeds where the number of oscillations was small, the 1/10 highest statistics have been omitted from the data. Comparisons between the various configurations are still valid. Figures 8 through 11 show the variations of the mean and rms data with velocity. Figure 12 shows the effects of trunk pressure on performance, while the effect of mean trunk pressure on the rms accelerations is presented in Figure 13. Figures 14 and 15 contain the habitability results in ISO format compared with the ISO 1-hour FDP boundary line[2]. Additional rough water results are presented in the Appendix. These include the effects of venting the trunk and cushion to improve the ride quality.

Fixed-trim calm water pitch stability tests results are given in Table 4 and in Figures 16 through 21 for the three basic velocities of 11.7, 20 and 30 knots.

Calm water yaw stability test results are presented in Table 5 and in Figures 22 through 27 for the three basic velocities of 11.7, 20 and 30 knots at two trim angles and in Figures 28 and 29 at 11.7 knots for several trunk pressures.

All stability test results (pitch and yaw) are reported in a right-handed body axis system having its origin 14.53 ft aft of Station 100 and 3.075 ft above the hard bottom (wet deck). For convenience the negative sign of the X-force has been omitted from the tables.

The following entries appear in the stability tables:

Run Number	
Yaw angle, degrees	positive, bow to starboard
Trim angle, degrees	positive bow-up
Velocity, fps	
Heave, ft	nominal CG height above water level
Longitudinal force, X, lb	positive aft
Lateral force, Y, lb	positive to starboard
Yaw moment, N, ft-lb	positive, bow to starboard
Roll moment, K, ft-lb	positive, starboard down
Pitch moment, M, ft-lb	positive bow-up
Cushion pressure, PC, psf	
Trunk pressure, PT, psf	
Equivalent drag, EQV DRAG, lb	Drag + Cushion Fan Drag
Cushion air flow rate, Q, cfs	

All forces and moments listed in stability Tables 4 and 5 are expressed in thousands.

A complete set of photographs of the calm water runs has been supplied to the LVA Technical Management Office, Code 112, DTNSRDC.

DISCUSSION

Calm Water Performance

The baseline configuration of the FSACV consists of a displacement of 56,000 lb and nominal values of trunk pressure and cushion flow of 220 psf and 1180 cfs respectively. The calm water performance of this configuration as a function of velocity and LCG is presented in Figure 6A. Similar plots are included in Figures 6B and 6C for trunk pressures of 150 and 117 psf. The large hump in the drag curve occurs at 11.7 knots which can be attenuated with the proper choice of LCG position. The data indicates that over the speed range from 11 to 35 knots, the optimum choice

of LCG would be 13.78 ft aft of Station 100 for all three trunk pressures.

The effect on drag of changing the cushion flow at the baseline configuration and 13.78 LCG can be found in the table below:

DRAG, LB			
SPEED KNOTS	CUSHION FLOW, CFS		
	700	1180	1700
11.7	15064	10480	10631
20.0	-	6109	6124
30.0	-	5495	5076
TOTAL EQUIVALENT DRAG*, LB			
11.7	17030	15680	18132
20.0	-	9247	10736
30.0	-	7751	8439

*Includes cushion fan drag.

Increasing the flow from 1180 to 1700 cfs does not significantly alter the drag at 11.7 and 20.0 knots. At 30 knots, a small reduction of 8% is realized. However, when the total equivalent drag is compared, the data shows that increasing the flow is detrimental, i.e. more horsepower would be required to operate the craft at 1700 cfs than at the 1180 cfs flow condition. Decreasing the flow to 700 cfs at the 11.7 knot speed resulted in a low trim attitude and loss in cushion pressure. The drag consequently increased substantially. A cushion flow of 1180 cfs, therefore, produces the best performance in smooth water.

The results of changing the trunk pressure are shown in Figure 7. Decreasing this parameter from 350 to 115 psf reduces the drag dramatically on the order of 30% at the hump speed of 11.7 knots and over 35% at 30 knots, without seriously affecting the other performance characteristics such as cushion pressure, heave and trim. Further reductions in trunk pressure causes a loss in cushion pressure along with increasing drag and changes in the running attitude of the craft.

The effect of unloading the weight of the craft due to the vertical component of thrust is shown in the table below. A shaft angle of 19.0 degrees was used in the calculation of this component. The greatest effect is experienced at the hump speed where the drag is lowered about 600 lbs (8%). This is due primarily to the combination of high trim and drag at this speed.

Effect of Thrust Unloading
Trunk Pressure = 117 psf, Q = 1180 cfs, LCG = 13.78 ft

Load on Water, lb	Speed fps	Drag lb	Trim degree	Heave ft	PC psf	PT psf	Q cfs	Run
56,000	8.9	6865	1.0	2.6	92	118	1171	349(2)
53,600(1)		6536	1.0	2.7	81	118	1198	370(2)
56,000	10.0	8406	0.8	2.4	62	119	1237	373(2)
52,780(1)		8003	0.9	2.7	55	118	1249	363(2)
56,000	11.7	7667	7.4	2.6	86	114	1186	340
52,480(1)		7098	6.9	2.9	82	118	1196	365
56,000	15.0	6701	6.4	2.9	90	117	1176	344
53,000(1)		6102	5.9	3.1	79	118	1200	367
56,000	20.0	5697	4.3	3.8	92	116	1171	345
53,680(1)		5301	4.0	3.7	90	117	1176	368
56,000	30.0	3640	1.8	4.1	91	114	1174	346
54,650(1)		3863	1.8	4.1	91	115	1174	369

(1) Accounts for unloading due to thrust, shaft angle = 19 degrees.
(2) Slight porpoising.

Rough Water Performance

The performance of the FSACV in Sea State 2 as a function of speed is described in Figures 8 through 10 for nominal trunk pressures of 120 and 220 psf. An LCG of 14.53 appears to be better in waves in the vicinity of hump speeds where the drag is minimized. At post hump speeds, there is little effect of LCG shift on the drag, motions, and accelerations (see also Figure 12). As one would expect the accelerations increase significantly with higher speeds. Decreasing the trunk pressure from

220 to 120 psf consistently lowers the drag over most of the speed range. Heave motions are unaffected while pitch motions, in the speed range of 10 to 20 knots, are generally higher at the lower trunk pressure (Fig.9). Acceleration levels improve at the bow and stern for speeds greater than 15 knots when the trunk pressure drops from 220 to 120 psf. The change in the CG accelerations is minimal with trunk pressure, as are all the accelerations below 15 knots.

Accelerations normal to the keel were measured at three longitudinal positions and their distribution along the length of the craft are plotted for various speeds and trunk pressures in Figure 11. It is immediately apparent that the minimum accelerations occur in the vicinity of the LCG; and the highest ones for the troop capsule occur at the stern. Thus troops sitting in the aftmost section of the troop compartment will be subjected to the largest "g" loads. This differs from a planing hull, where the accelerations become increasingly more severe toward the bow of the craft.

The influence of trunk pressure and cushion air flow on the rough water performance is shown in Figures 12 and 13. As in smooth water, decreasing the trunk pressure improves the drag in Sea State 2. What is even more noteworthy is the significant reductions in rms accelerations at 30 knots (Figure 13) particularly at the stern where a decrease in trunk pressure from 220 to 95 psf accounts for 50% smaller accelerations. Further reductions in trunk pressure can lower the stern accelerations even more; however the drag will now begin to increase (see Table 3). A cushion flow change from 1200 to 1750 cfs -- which also lowers the pressure/flow slope by 50% -- has a negligible effect on the rms accelerations.

Spectral analysis of specific runs was used to obtain habitability data in the ISO format[2]. At 30 knots and a trunk pressure of 95 psf, the 1/3-octave rms accelerations at the stern are presented in Figure 14 along with the ISO 1-hour "fatigue-decreased-proficiency" (FDP) boundary. It is clear that even at this low value of trunk pressure, the limit is exceeded. Increasing the trunk pressure to 155 psf degrades the habitability. (Figure 15).

Longitudinal Stability

Figures 16 through 21 present the fixed-trim, calm-water stability results at 11.7, 20 and 30 knots for four trunk pressure variations. A measure of the degree of pitch stiffness or longitudinal stability is the slope of the pitch moment versus trim curve. A negative slope assures positive stability while a positive slop implies that the craft is unstable in pitch. From the pitch stability curves of Figures 16-18, the craft exhibits positive stability for the nominal design trims at the post hump speeds of 20 and 30 knots, with the degree of stiffness increasing with higher trunk pressure. At the hump speed of 11.7 knots, the maximum pitch stability occurs at a trunk pressure of 150 psf. The stability is virtually neutral at 95 and 220 pfs; and the craft becomes unstable for the trunk pressure of 340 psf below 4 degrees trim.

The drag versus trim curves are useful for determining the best LCG for minimum drag. The characteristic "bucket" shape defines an optimum trim which can then be related to an LCG position from the pitch moment characteristics. For the FSACV the optimum trims are obtained at the design or slightly forward LCG positions (14.53 and 13.78 ft aft of station 100).

Figures 19 through 21 describe the cushion pressure and CG heave as a function of trim. As the trim decreases from its optimum value, the cushion pressure drops with a corresponding lowering of the CG heave. This would indicate that a greater proportion of the craft's lift support is being transferred from the cushion to the trunk (buoyancy).

The fixed trim results generally agree well with the results from the free-to-trim tests.

Directional Stability

The FSACV craft exhibits little or no directional stability at or near design trim and generally is directionally unstable at lower trims (see Figures 22-24). The model was tested without appendages, however,

so that the results only represent the "bare hull" configuration. Future testing should include the effects of appendages, roll angle, and further combinations of trim and trunk pressure.

The offsets in the forces and moments at zero yaw are nominally within the precision of measurement. However at combinations of low trim and high speed, the amount of offset suggests an asymmetry in the model which may be due to the way the trunk deforms under hydrodynamic load.

The remaining figures (25 to 29) include drag, roll moment and pitch moment as a function of yaw angle for three speeds plus the effect of trunk pressure on the directional stability characteristics at 11.7 knots. The body axis drag appears to be rather insensitive to yaw angle, while decreasing the trunk pressure at 11.7 knots tends to improve the directional stability of the craft.

CONCLUDING REMARKS

A model of the FSACV was tested in calm water and in irregular head seas to characterize the craft in the areas of performance, seakeeping, habitability and stability. Major parameters were speed, LCG, trunk pressure and cushion air flow.

The primary parameter affecting both resistance and rough water rms accelerations of the craft was found to be trunk pressure. The optimum combination of minimum drag and lowest accelerations was obtained at a trunk pressure of 115 psf. Optimum LCG's in calm water and in Sea State 2 ($H_{1/3}$ = 2.2 ft) were respectively 13.78 and 14.53 ft aft of station 100 (13.59 and 12.84 ft forward of transom).

Pitch stability at 20 and 30 knots was good at or near the optimum trims. At the hump speed of 11.7 knots, the pitch stability was very sensitive to trunk pressure. Positive pitch stability was obtained at a trunk pressure of 150 psf, but was either neutral or destabilizing at higher or lower values. Nonetheless, the model showed no signs of plow-in during the free-to-trim tests despite the lack of pitch stability.

The craft without appendages has little or no directional stability.

Habitability standards in the form of the ISO 1-hour "FDP" boundary were exceeded for the FSACV at 30 knots in a Sea State 2. The critical area is at the stern where personnel furthest aft in the troop compartment will be experiencing the highest rms accelerations.

It is recommended that further study be made to soften the ride qualities of the craft including reduced trunk pressure operation. In addition directional stability tests with appendages are needed at combinations of fixed roll, yaw and trim angles.

REFERENCES

1. Fridsma, G., "Performance, Stability and Seakeeping Characteristics of a Model of the 100-B SES Testcraft," Part I, SIT-DL-74-1673, June 1974.

2. ISO: "Guide for the Evaluation of Human Exposure to Whole-Body Vibration," International Standard 2631, First Edition, 1974-07-01.

TABLE 1

CONFIGURATION PARTICULARS

	1/9-Model	Prototype
Displacement, lb	74.8	56,000
Tow Point and Nominal CG Location		
aft of Bow Station 100, ft	1.615	14.53
forward of transom, ft	1.427	12.84
above hard bottom, ft	0.342	3.075
Gyradius, ft	0.912	8.21
Wet Deck (hard bottom)		
beam, ft	1.188	10.69
length, ft	3.042	27.38

WAVE STATISTICS

Nominal Sea State	Significant Wave Height ft	Average Wave Height ft	Period of Maximum Energy sec	Average Period sec
2	2.2	1.4	4.1	3.2

TABLE 2-1

CALM WATER PERFORMANCE RESULTS

LCG = 14.53 FT

RUN	VEL KT	TRIM DEG	HEAVE FT	DRAG LB	PC PSF	PT PSF	FAN DRAG LB	Q CFS
41	0.0	2.6	3.0	741.	77.	222.		1205.
39	5.0	3.3	2.6	1707.	71.	218.	10250.	1217.
38	7.5	3.9	2.8	4073.	67.	219.	6470.	1227.
40	10.0	4.4	2.8	8168.	79.	223.	5645.	1200.
4	11.7	7.4	3.0	11238.	85.	220.	5096.	1188.
13	12.5	7.6	2.9	11006.	89.	220.	4968.	1179.
7	15.0	6.3	3.2	8273.	91.	218.	4206.	1174.
8	20.4	4.1	3.8	6424.	91.	218.	3106.	1174.
9	25.0	3.0	4.1	6304.	98.	216.	2677.	1157.
10	30.0	2.4	4.1	6611.	100.	213.	2269.	1152.
11	35.0	1.9	4.1	7464.	101.	215.	1959.	1149.

LCG = 13.78 FT

RUN	VEL KT	TRIM DEG	HEAVE FT	DRAG LB	PC PSF	PT PSF	FAN DRAG LB	Q CFS
32	0.0	1.5	3.1	711.	79.	221.		1200.
33	5.0	2.3	2.8	1572.	71.	218.	10288.	1217.
34	7.5	2.3	2.8	3249.	81.	224.	7680.	1196.
30	10.0	1.1	2.6	9591.	80.	228.	5698.	1198.
31	11.7	6.9	2.9	10459.	86.	222.	5168.	1183.
15	11.7	7.0	2.9	10519.	87.	222.	5204.	1183.
16	15.0	5.8	3.2	7494.	90.	219.	4187.	1176.
17	20.0	3.8	3.8	6109.	90.	218.	3138.	1176.
18	25.0	2.5	4.1	5488.	98.	215.	2683.	1157.
19	30.0	1.9	4.1	5623.	102.	214.	2315.	1145.
20	35.0	1.6	4.2	6199.	104.	213.	2005.	1140.

LCG = 13.03 FT

RUN	VEL KT	TRIM DEG	HEAVE FT	DRAG LB	PC PSF	PT PSF	FAN DRAG LB	Q CFS
37	0.0	-0.2	3.4	262.	80.	224.		1200.
36	5.0	1.1	3.0	1400.	77.	220.	10979.	1205.
35	7.5	0.7	2.8	2710.	86.	222.	8009.	1186.
23	10.0	-2.2	2.4	13177.	118.	224.	7684.	1101.
* 24	11.7	0.5	2.4	16359.	59.	230.	3679.	1242.
25	15.0	5.3	3.2	6686.	87.	219.	4069.	1183.
26	20.0	3.4	3.8	5915.	88.	217.	3084.	1181.
27	25.0	1.9	4.1	5099.	98.	215.	2684.	1157.
28	30.0	1.1	4.2	5989.	99.	214.	2261.	1152.
29	35.0	0.7	4.3	6768.	104.	214.	2005.	1140.

TABLE 2-2

CALM WATER PERFORMANCE RESULTS

TRUNK PRESSURE EFFECTS AT LCG = 13.78 FT

RUN	VEL KT	TRIM DEG	HEAVE FT	DRAG LB	PC PSF	PT PSF	FAN DRAG LB	Q CFS
61	11.7	7.6	2.1	7816.	84.	89.	5032.	1191.
58	11.7	6.7	2.9	8715.	87.	155.	5185.	1183.
57	11.7	6.8	2.9	9643.	87.	185.	5216.	1183.
45	11.7	7.7	2.9	11837.	90.	340.	5363.	1176.
44	11.7	7.7	2.9	11799.	91.	352.	5397.	1174.
43	11.7	7.8	2.9	11897.	91.	388.	5375.	1174.
42	11.7	8.0	3.0	12151.	92.	453.	5442.	1171.
59	20.0	4.1	3.7	5727.	95.	153.	3256.	1164.
46	20.0	3.6	3.9	6873.	94.	338.	3230.	1166.
62	30.0	1.6	3.8	4402.	95.	84.	2175.	1164.
60	30.0	1.9	4.1	5069.	101.	151.	2289.	1149.
50	30.0	1.9	4.2	5480.	103.	207.	2322.	1142.
49	30.0	1.8	4.2	5495.	99.	216.	2256.	1154.
48	30.0	1.8	4.2	5720.	103.	248.	2320.	1142.
47	30.0	1.7	4.2	6371.	101.	335.	2282.	1149.

HIGH FLOW AT LCG = 13.78 FT

51	11.7	7.1	3.0	10631.	87.	221.	7501.	1716.
52	20.0	4.0	3.8	6124.	92.	216.	4612.	1696.
53	30.0	1.8	4.2	5076.	103.	214.	3363.	1655.
54	11.7	7.8	3.0	12069.	89.	347.	7691.	1706.
55	20.0	3.7	4.0	6865.	92.	344.	4615.	1696.
56	30.0	1.7	4.3	5892.	103.	342.	3361.	1657.

LOW FLOW AT LCG = 13.78 FT

* 63	11.7	1.4	2.4	15064.	57.	230.	1966.	688.

*Unsteady running condition.

TABLE 2-3

CALM WATER PERFORMANCE RESULTS

RUN	VEL KT	TRIM DEG	HEAVE FT	DRAG LB	PC PSF	PT PSF	FAN DRAG LB	Q CFS	LCG FT	LOAD LB
336	0.0	3.1	2.7	681.	76.	153.		1208.	14.53	56001.
335	5.0	3.5	2.4	1797.	66.	153.	9540.	1230.	14.53	56001.
333	7.5	3.6	2.6	4208.	77.	151.	7302.	1205.	14.53	56001.
* 332	10.0	2.8	2.6	9179.	84.	151.	5946.	1188.	14.53	56001.
331	11.7	7.4	2.8	9516.	84.	152.	5021.	1191.	14.53	56001.
334	15.0	6.8	2.9	7734.	90.	151.	4162.	1176.	14.53	56001.
337	20.0	4.7	3.6	6746.	93.	151.	3215.	1169.	14.53	56001.
338	30.0	2.4	4.0	6154.	98.	148.	2237.	1157.	14.53	56001.
313	0.0	1.8	2.9	621.	79.	152.		1200.	13.78	56001.
314	5.0	2.4	2.5	1580.	72.	152.	10306.	1217.	13.78	56001.
315	7.5	2.3	2.6	3399.	77.	152.	7339.	1205.	13.78	56001.
* 316	10.0	0.4	2.6	9276.	113.	152.	7419.	1115.	13.78	56001.
339	11.7	6.6	2.9	8790.	84.	152.	5069.	1188.	13.78	56001.
* 300	11.7	6.4	2.8	9037.	84.	153.	5037.	1191.	13.78	56001.
301	15.0	6.2	3.0	7112.	89.	152.	4146.	1179.	13.78	56001.
302	20.0	4.0	3.7	5802.	94.	151.	3249.	1166.	13.78	56001.
303	30.0	1.9	4.1	5128.	101.	149.	2286.	1149.	13.78	56001.
312	0.0	0.0	3.1	225.	80.	152.		1198.	13.03	56001.
311	5.0	1.2	2.7	1318.	78.	152.	11034.	1205.	13.03	56001.
309	7.5	0.6	2.7	2733.	81.	152.	7665.	1196.	13.03	56001.
310	7.5	0.7	2.7	2710.	81.	152.	7647.	1198.	13.03	56001.
308	10.0	-0.7	2.5	9359.	103.	152.	6974.	1142.	13.03	56001.
* 304	11.7	3.3	2.6	10833.	72.	151.	4424.	1215.	13.03	56001.
305	15.0	5.7	3.0	6499.	86.	152.	4036.	1183.	13.03	56001.
306	20.0	3.5	3.7	5465.		152.		1346.	13.03	56001.
307	30.0	1.2	4.1	5435.	95.	148.	2178.	1164.	13.03	56001.
* 323	0.0	-0.7	3.1	-90.	74.	154.		1213.	12.28	56001.
325	5.0	-0.0	2.9	1026.	72.	153.	10326.	1217.	12.28	56001.
326	7.5	-1.0	2.7	2493.	80.	153.	7603.	1198.	12.28	56001.
327	10.0	-1.7	2.3	10294.	86.	153.	6013.	1186.	12.28	56001.
324	11.7	2.4	2.6	11485.	68.	151.	4203.	1225.	12.28	56001.
* 328	15.0	5.7	3.0	6543.	78.	152.	3708.	1203.	12.28	56001.
329	20.0	3.4	3.7	5585.	80.	152.	2826.	1200.	12.28	56001.
330	30.0	0.9	4.1	6281.	92.	149.	2131.	1171.	12.28	56001.
317	0.0	-0.4	3.1	60.	83.	152.		1193.	12.78	58248.
318	5.0	0.8	2.7	1348.	82.	152.	11576.	1193.	12.78	58248.
319	7.5	0.1	2.6	2733.	83.	152.	7835.	1191.	12.78	58248.
320	10.1	-0.5	2.3	10482.	94.	152.	6447.	1166.	12.78	58248.
* 321	11.8	3.2	2.5	11635.	71.	151.	4360.	1217.	12.78	58248.
322	15.0	6.0	2.9	7000.	85.	152.	3970.	1188.	12.78	58248.

TABLE 2-4
CALM WATER PERFORMANCE RESULTS

	RUN	VEL KT	TRIM DEG	HEAVE FT	DRAG LB	PC PSF	PT PSF	FAN DRAG LB	Q CFS	LCG FT	LOAD LB
*	350	10.0	2.5	2.6	8535.	67.	119.	4860.	1227.	14.53	56001.
	355	11.7	8.8	2.5	8116.	82.	118.	4962.	1193.	14.53	56001.
	362	15.0	7.2	2.9	7674.	90.	117.	4187.	1176.	14.53	56001.
	361	20.0	4.7	3.7	6499.	93.	117.	3205.	1169.	14.53	56001.
	360	30.0	2.4	4.0	4372.	89.	115.	2063.	1179.	14.53	56001.
	343	7.5	1.9	2.6	3504.	80.	118.	7565.	1198.	13.78	56001.
*	349	8.9	1.0	2.6	6865.	92.	118.	7181.	1171.	13.78	56001.
	373	10.0	0.8	2.4	8408.	62.	119.	4571.	1237.	13.78	56001.
*	342	10.0	0.9	2.5	8483.	60.	119.	4423.	1239.	13.78	56001.
	340	11.7	7.4	2.6	7667.	86.	114.	5153.	1186.	13.78	56001.
	344	15.0	6.4	2.9	6701.	90.	117.	4174.	1176.	13.78	56001.
	345	20.0	4.3	3.8	5697.	92.	116.	3200.	1171.	13.78	56001.
	346	30.0	1.8	4.1	3639.	91.	114.	2110.	1174.	13.78	56001.
	347	30.0	1.8	4.1	3624.	91.	115.	2108.	1174.	13.78	56001.
	348	30.0	1.8	4.1	3654.	91.	114.	2102.	1174.	13.78	56001.
	351	10.0	-0.9	2.4	8700.	61.	118.	4445.	1239.	13.03	56001.
	352	11.7	5.7	2.5	7764.	81.	116.	4900.	1196.	13.03	56001.
	354	10.0	-2.7	2.2	8805.	64.	118.	4687.	1232.	12.28	56001.
	353	11.7	4.7	2.5	6970.	74.	117.	4531.	1213.	12.28	56001.
	357	15.0	4.9	2.9	6259.	78.	119.	3690.	1203.	12.28	56001.
	358	20.0	3.3	3.7	5465.	82.	116.	2893.	1196.	12.28	56001.
	359	30.0	0.8	4.0	5338.	89.	115.	2064.	1179.	12.28	56001.
	356	11.7	2.8	2.3	7075.	65.	116.	4421.	1232.	11.53	56001.

TESTS INCLUDING THRUST UNLOADING

*	370	8.9	1.1	2.7	6536.	81.	118.	6447.	1198.	13.78	53696.
*	363	10.0	4.9	2.7	8043.	55.	113.	4102.	1249.	13.78	52782.
	364	11.7	6.8	2.9	7038.	71.	118.	4361.	1217.	13.78	52033.
	365	11.7	6.9	2.8	7098.	82.	118.	4921.	1196.	13.78	52483.
	366	15.0	5.9	3.1	6057.	80.	118.	3797.	1198.	13.78	52857.
	367	15.0	5.9	3.1	6102.	79.	118.	3735.	1200.	13.78	53007.
	368	20.0	4.0	3.7	5301.	90.	117.	3122.	1176.	13.78	53681.
	369	30.0	1.8	4.1	3863.	91.	115.	2100.	1174.	13.78	54654.
	445	30.0	3.8	3.9	5795.	90.	81.	2141.	1176.	14.53	56001.
	443	30.0	2.4	4.4	4223.	95.	113.	2239.	1164.	14.53	56001.
	446	30.0	2.3	4.3	4597.	95.	117.	2246.	1164.	14.53	56001.
	420	30.0	2.2	4.8	5001.	96.	127.	2261.	1162.	14.53	56001.
	444	30.0	2.3	4.5	5136.	97.	134.	2269.	1159.	14.53	56001.
	399	8.9	4.2	1.9	5653.	84.	78.	6707.	1188.	14.53	56001.
	400	11.7	9.5	1.9	8617.	84.	79.	5023.	1191.	14.53	56001.
*	401	30.0	3.7	3.3	5870.	87.	76.	2041.	1183.	14.53	56001.
	406	11.7	5.0	1.6	8505.	38.	80.	2457.	1281.	13.78	56001.
	407	15.0	7.9	2.4	7801.	82.	80.	3856.	1196.	13.78	56001.
	408	30.0	2.9	3.3	5697.	81.	76.	1925.	1196.	13.78	56001.

TABLE 3 TEST CONDITIONS

PERFORMANCE RESULTS IN SEA STATE 2

RUN	LCG ft	NOMINAL PT psf	VEL kt	NOMINAL AIR FLOW cfs
67	14.53	95	10.0	1200
101			11.7	
98			15.0	
99			20.0	
100			30.0	
95		155	11.7	
96			15.0	
97			20.0	
90			30.0	
76		220	5.0	
75			7.5	
68			10.0	
74			11.7	
70			15.0	
71			20.0	
72			25.0	
69			30.0	
73			35.0	
103	13.78	95	10.0	
102			11.7	
104			20.0	
105			30.0	
94		155	11.7	
93			15.0	
92			20.0	
91			30.0	
86		195	15.0	
88			20.0	
87			30.0	
77		220	0.0	
78			5.0	
79			7.5	
80			10.0	
81			11.7	
85			15.0	
83			20.0	
84			30.0	
89		307	30.0	
111	13.78	95	11.7	1750
112			30.0	
109		155	11.7	
110			30.0	
108		220	11.7	
107			20.0	
106			30.0	

Additional Tests at Low Trunk Pressures

404	14.53	81	10.0	1200
394		121	10.0	
415		66	11.7	
413		69	11.7	
403		83	11.7	
395		120	11.7	
380		120	11.7	
405		83	15.0	
381		120	15.0	
382		119	20.0	
414		73	30.0	
412		81	30.0	
402		82	30.0	
383		118	30.0	
391	13.78	118	5.0	
392		119	7.5	
396		125	10.0	
410		87	11.7	
375		121	11.7	
376		121	15.0	
377		120	20.0	
378		119	30.0	
411		120	30.0	
384	13.03	122	11.7	
385		119	15.0	
386		120	20.0	

TABLE 3-1

PERFORMANCE RESULTS IN SEA STATE 2

RUN 67 — VELOCITY 10.0 KT — WAVE ENCOUNTERS 47
DRAG 8617. LB — FAN DRAG 4600. LB
LCG 14.53 FT — AIR FLOW 1234. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	3.6	2.48	36	6.8	0.4	8.5	-1.3		
HEAVE	FT	2.4	0.37	35	2.9	2.0	3.3	1.8		
BOW ACCEL	G	-0.0	0.32	48	0.7	-0.6	1.2	-0.8	1.8	-0.9
CG ACCEL	G	-0.0	0.18	47	0.5	-0.4	0.8	-0.5	1.2	-0.7
STERN ACCEL	G	-0.0	0.19	32	0.5	-0.5	0.8	-0.6		
PC	PSF	63.	16.0	31	106.	29.	127.	20.		
PT	PSF	101.	26.4	36	155.	57.	171.	45.		

RUN 101 — VELOCITY 11.7 KT — WAVE ENCOUNTERS 46
DRAG 8542. LB — FAN DRAG 4607. LB
LCG 14.53 FT — AIR FLOW 1208. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	8.4	2.96	38	12.1	4.8	14.1	2.7		
HEAVE	FT	2.2	0.28	34	2.6	1.9	2.8	1.8		
BOW ACCEL	G	-0.0	0.44	55	0.8	-0.6	1.4	-0.9	1.9	-1.2
CG ACCEL	G	-0.0	0.24	89	0.5	-0.4	0.8	-0.5	1.1	-0.7
STERN ACCEL	G	-0.0	0.36	71	0.7	-0.5	1.1	-0.9	1.4	-1.1
PC	PSF	75.	34.4	63	133.	29.	181.	3.	281.	-34.
PT	PSF	94.	23.4	36	155.	51.	178.	39.		

RUN 98 — VELOCITY 15.0 KT — WAVE ENCOUNTERS 39
DRAG 9523. LB — FAN DRAG 3703. LB
LCG 14.53 FT — AIR FLOW 1203. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	7.8	2.95	37	11.3	4.2	13.3	2.3		
HEAVE	FT	2.7	0.35	30	3.1	2.3	3.4	2.1		
BOW ACCEL	G	-0.0	0.58	66	0.8	-0.6	1.4	-1.0	1.8	-1.2
CG ACCEL	G	-0.0	0.29	81	0.5	-0.4	0.8	-0.6	0.9	-0.7
STERN ACCEL	G	-0.0	0.43	57	0.9	-0.5	1.3	-0.9	1.6	-1.1
PC	PSF	78.	45.3	84	151.	30.	238.	-11.	352.	-51.
PT	PSF	96.	31.2	65	156.	56.	188.	41.	221.	31.

TABLE 3-2

PERFORMANCE RESULTS IN SEA STATE 2

RUN 99 — VELOCITY 20.0 KT — WAVE ENCOUNTERS 31
DRAG 8048. LB — FAN DRAG 2581. LB
LCG 14.53 FT — AIR FLOW 1217. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	5.4	3.06	26	9.5	1.5	11.2	-0.3		
HEAVE	FT	3.4	0.34	26	3.8	3.0	4.1	2.8		
BOW ACCEL	G	-0.0	0.70	53	1.0	-0.7	1.7	-1.1	2.3	-1.2
CG ACCEL	G	-0.0	0.35	79	0.5	-0.4	0.9	-0.6	1.2	-0.8
STERN ACCEL	G	-0.0	0.49	61	0.8	-0.5	1.5	-0.8	2.1	-1.2
PC	PSF	72.	53.9	73	150.	10.	232.	-47.	317.	-89.
PT	PSF	95.	38.0	64	158.	53.	200.	37.	244.	26.

RUN 100 — VELOCITY 30.0 KT — WAVE ENCOUNTERS 25
DRAG 8587. LB — FAN DRAG 2070. LB
LCG 14.53 FT — AIR FLOW 1179. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	3.1	2.68	22	6.1	-0.0	8.2	-1.4		
HEAVE	FT	3.6	0.39	20	4.1	3.2	4.5	2.9		
BOW ACCEL	G	-0.0	0.82	46	1.2	-0.6	2.0	-1.1	2.7	-1.2
CG ACCEL	G	-0.0	0.46	53	0.8	-0.4	1.2	-0.7	1.5	-0.9
STERN ACCEL	G	-0.0	0.53	51	0.7	-0.6	1.3	-1.0	1.7	-1.3
PC	PSF	89.	66.2	70	171.	37.	254.	-29.	392.	-115.
PT	PSF	95.	49.2	48	176.	53.	234.	26.	284.	10.

RUN 95 — VELOCITY 11.7 KT — WAVE ENCOUNTERS 46
DRAG 9748. LB — FAN DRAG 4622. LB
LCG 14.53 FT — AIR FLOW 1208. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	6.7	3.15	36	10.6	3.0	13.1	0.8		
HEAVE	FT	2.8	0.33	36	3.3	2.5	3.5	2.2		
BOW ACCEL	G	-0.0	0.45	52	0.9	-0.7	1.3	-1.0	1.8	-1.4
CG ACCEL	G	-0.0	0.26	72	0.5	-0.4	0.9	-0.5	1.1	-0.6
STERN ACCEL	G	-0.0	0.38	60	0.6	-0.6	1.0	-0.9	1.4	-1.1
PC	PSF	76.	23.2	52	134.	42.	161.	30.	183.	20.
PT	PSF	155.	30.0	52	217.	109.	237.	91.	252.	83.

TABLE 3-3

PERFORMANCE RESULTS IN SEA STATE 2

RUN 96 VELOCITY 15.0 KT WAVE ENCOUNTERS 39
DRAG 9388. LB FAN DRAG 3849. LB
LCG 14.53 FT AIR FLOW 1196. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	7.4	2.94	41	10.4	3.8	13.0	1.7		
HEAVE	FT	3.1	0.35	32	3.5	2.7	3.8	2.4		
BOW ACCEL	G	-0.0	0.69	70	1.1	-0.7	1.9	-1.1	2.4	-1.3
CG ACCEL	G	-0.0	0.34	86	0.5	-0.4	0.9	-0.6	1.1	-0.7
STERN ACCEL	G	-0.0	0.60	77	0.9	-0.7	1.8	-1.4	2.1	-1.7
PC	PSF	82.	30.8	77	138.	41.	181.	13.	212.	-26.
PT	PSF	154.	41.7	86	219.	105.	256.	84.	293.	71.

RUN 97 VELOCITY 20.0 KT WAVE ENCOUNTERS 33
DRAG 7981. LB FAN DRAG 2719. LB
LCG 14.53 FT AIR FLOW 1208. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	5.1	2.73	33	8.0	1.8	10.6	-0.0		
HEAVE	FT	3.8	0.35	28	4.2	3.4	4.5	3.2		
BOW ACCEL	G	-0.0	0.81	56	1.4	-0.8	2.3	-1.1	2.9	-1.3
CG ACCEL	G	-0.0	0.38	73	0.6	-0.5	1.0	-0.7	1.2	-0.8
STERN ACCEL	G	-0.0	0.62	65	0.9	-0.8	1.6	-1.4	2.1	-1.6
PC	PSF	76.	32.8	75	131.	41.	174.	18.	221.	-0.
PT	PSF	153.	47.3	74	226.	103.	270.	75.	318.	55.

RUN 90 VELOCITY 30.0 KT WAVE ENCOUNTERS 23
DRAG 8610. LB FAN DRAG 1903. LB
LCG 14.53 FT AIR FLOW 1198. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	2.7	4.01	20	7.7	-2.8	10.2	-4.1		
HEAVE	FT	4.3	0.49	17	4.9	3.8	5.5	3.6		
BOW ACCEL	G	-0.0	1.11	42	1.7	-0.8	2.9	-1.5		
CG ACCEL	G	-0.0	0.55	60	0.8	-0.5	1.5	-0.9	2.1	-1.1
STERN ACCEL	G	-0.0	0.99	51	1.3	-0.7	2.5	-1.8	3.4	-2.5
PC	PSF	80.	55.3	59	156.	32.	213.	-21.	295.	-103.
PT	PSF	154.	86.8	60	257.	84.	356.	40.	483.	21.

TABLE 3-4

PERFORMANCE RESULTS IN SEA STATE 2

RUN 76 VELOCITY 5.0 KT WAVE ENCOUNTERS 74
DRAG 2066. LB FAN DRAG 10031. LB
LCG 14.53 FT AIR FLOW 1222. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	3.0	2.53	58	6.5	-0.3	8.1	-1.8	9.2	-3.1
HEAVE	FT	2.7	0.35	54	3.1	2.3	3.5	2.0	3.7	1.9
BOW ACCEL	G	-0.0	0.24	64	0.5	-0.6	0.7	-0.8	0.8	-1.0
CG ACCEL	G	-0.0	0.12	45	0.4	-0.3	0.6	-0.4		
STERN ACCEL	G	-0.0	0.19	60	0.6	-0.4	1.1	-0.5	1.5	-0.6
PC	PSF	70.	34.6	78	211.	25.	327.	-0.	424.	-20.
PT	PSF	225.	12.3	15	282.	190.				

RUN 75 VELOCITY 7.5 KT WAVE ENCOUNTERS 62
DRAG 4949. LB FAN DRAG 6444. LB
LCG 14.53 FT AIR FLOW 1227. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	3.6	2.41	45	6.9	0.6	8.7	-1.1		
HEAVE	FT	2.7	0.39	40	3.3	2.3	3.6	2.0		
BOW ACCEL	G	-0.0	0.30	59	0.6	-0.6	0.8	-0.8	1.1	-1.0
CG ACCEL	G	-0.0	0.14	37	0.3	-0.3	0.4	-0.4		
STERN ACCEL	G	-0.0	0.19	44	0.5	-0.4	0.8	-0.6		
PC	PSF	66.	40.4	71	196.	29.	329.	-1.	456.	-29.
PT	PSF	226.	12.2	6	268.	186.				

RUN 68 VELOCITY 10.0 KT WAVE ENCOUNTERS 51
DRAG 11657. LB FAN DRAG 6306. LB
LCG 14.53 FT AIR FLOW 1174. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	2.9	2.44	36	6.1	-0.1	7.9	-1.5		
HEAVE	FT	2.6	0.42	34	3.2	2.1	3.5	1.9		
BOW ACCEL	G	-0.0	0.32	41	0.7	-0.7	1.0	-0.9		
CG ACCEL	G	-0.0	0.17	40	0.4	-0.4	0.6	-0.5		
STERN ACCEL	G	-0.0	0.19	34	0.5	-0.4	0.8	-0.5		
PC	PSF	91.	60.4	61	250.	28.	394.	-10.	470.	-70.
PT	PSF	233.	23.4	27	290.	188.	318.	176.		

TABLE 3-5

PERFORMANCE RESULTS IN SEA STATE 2

RUN 74 — VELOCITY 11.7 KT — WAVE ENCOUNTERS 47
DRAG 11657. LB — FAN DRAG 4826. LB
LCG 14.53 FT — AIR FLOW 1200. CFS

		MEAN	RMS OSC		AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	6.9	2.79	35	10.5	3.5	12.6	1.6		
HEAVE	FT	3.0	0.35	35	3.5	2.6	3.8	2.3		
BOW ACCEL	G	-0.0	0.50	58	1.0	-0.7	1.6	-1.1	2.0	-1.4
CG ACCEL	G	-0.0	0.27	65	0.6	-0.4	0.9	-0.6	1.1	-0.6
STERN ACCEL	G	-0.0	0.33	62	0.5	-0.5	0.9	-0.8	1.2	-1.0
PC	PSF	80.	30.8	73	145.	39.	184.	24.	212.	12.
PT	PSF	234.	26.6	57	291.	185.	318.	174.	338.	164.

RUN 70 — VELOCITY 15.0 KT — WAVE ENCOUNTERS 40
DRAG 10040. LB — FAN DRAG 4046. LB
LCG 14.53 FT — AIR FLOW 1183. CFS

		MEAN	RMS OSC		AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	6.5	2.63	42	9.1	3.3	11.5	1.3		
HEAVE	FT	3.3	0.38	34	3.7	2.9	4.0	2.6		
BOW ACCEL	G	-0.0	0.68	76	1.1	-0.7	2.1	-1.0	2.9	-1.3
CG ACCEL	G	-0.0	0.33	82	0.6	-0.4	0.9	-0.6	1.3	-0.7
STERN ACCEL	G	-0.0	0.56	89	0.8	-0.8	1.4	-1.5	1.8	-2.0
PC	PSF	87.	39.2	94	154.	43.	213.	20.	246.	4.
PT	PSF	238.	33.6	92	285.	190.	318.	178.	351.	171.

RUN 71 — VELOCITY 20.0 KT — WAVE ENCOUNTERS 31
DRAG 8700. LB — FAN DRAG 2982. LB
LCG 14.53 FT — AIR FLOW 1188. CFS

		MEAN	RMS OSC		AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	4.5	2.53	35	7.1	1.4	9.5	0.0		
HEAVE	FT	4.0	0.36	26	4.4	3.5	4.6	3.2		
BOW ACCEL	G	-0.0	0.81	56	1.5	-0.8	2.6	-1.2	3.2	-1.6
CG ACCEL	G	-0.0	0.36	72	0.6	-0.4	1.0	-0.6	1.2	-0.7
STERN ACCEL	G	-0.0	0.62	76	0.8	-0.8	1.3	-1.8	1.8	-2.2
PC	PSF	85.	33.9	79	137.	44.	176.	20.	209.	7.
PT	PSF	238.	43.3	84	293.	186.	332.	166.	368.	151.

TABLE 3-6

PERFORMANCE RESULTS IN SEA STATE 2

RUN 72 VELOCITY 25.0 KT WAVE ENCOUNTERS 28
DRAG 8310. LB FAN DRAG 2457. LB
LCG 14.53 FT AIR FLOW 1181. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	3.3	3.00	29	6.5	-0.3	9.2	-2.2		
HEAVE	FT	4.2	0.38	23	4.7	3.8	5.1	3.5		
BOW ACCEL	G	-0.0	1.00	58	1.7	-0.7	2.8	-1.3	3.2	-1.6
CG ACCEL	G	-0.0	0.44	73	0.7	-0.4	1.1	-0.7	1.5	-0.9
STERN ACCEL	G	-0.0	0.78	61	1.0	-0.9	1.8	-1.8	2.7	-2.2
PC	PSF	88.	38.5	68	148.	48.	193.	19.	224.	-4.
PT	PSF	245.	68.5	79	317.	180.	375.	151.	450.	131.

RUN 69 VELOCITY 30.0 KT WAVE ENCOUNTERS 23
DRAG 8947. LB FAN DRAG 1997. LB
LCG 14.53 FT AIR FLOW 1186. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	2.7	3.20	24	6.2	-1.3	9.1	-3.4		
HEAVE	FT	4.3	0.46	20	4.8	3.8	5.4	3.6		
BOW ACCEL	G	-0.0	1.12	48	1.9	-0.7	3.2	-1.4	3.9	-1.7
CG ACCEL	G	-0.0	0.52	65	0.8	-0.4	1.3	-0.8	1.7	-1.0
STERN ACCEL	G	-0.0	0.96	48	1.1	-0.9	2.4	-1.8	4.2	-2.7
PC	PSF	85.	54.5	64	165.	38.	226.	4.	273.	-21.
PT	PSF	248.	73.2	62	331.	173.	416.	140.	480.	119.

RUN 73 VELOCITY 35.0 KT WAVE ENCOUNTERS 19
DRAG 11073. LB FAN DRAG 1538. LB
LCG 14.53 FT AIR FLOW 1210. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	2.5	4.66	22	6.9	-2.9	10.7	-6.0		
HEAVE	FT	4.5	0.70	16	5.2	3.8	5.9	3.7		
BOW ACCEL	G	-0.0	1.52	42	2.1	-1.1	4.3	-1.9		
CG ACCEL	G	0.0	0.64	59	1.0	-0.5	1.7	-0.9	2.5	-1.2
STERN ACCEL	G	-0.0	1.51	42	2.0	-1.1	4.1	-3.2		
PC	PSF	75.	62.8	65	160.	16.	226.	-39.	283.	-99.
PT	PSF	254.	128.6	59	379.	154.	552.	104.	704.	64.

TABLE 3-7

PERFORMANCE RESULTS IN SEA STATE 2

RUN 103 VELOCITY 10.0 KT WAVE ENCOUNTERS 51
DRAG 7921. LB FAN DRAG 5016. LB
LCG 13.78 FT AIR FLOW 1222. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	1.2	2.19	37	3.8	-1.8	5.4	-3.1		
HEAVE	FT	2.2	0.33	33	2.6	1.8	3.0	1.8		
BOW ACCEL	G	-0.0	0.29	41	0.8	-0.5	1.3	-0.6		
CG ACCEL	G	-0.0	0.17	45	0.5	-0.4	0.9	-0.5		
STERN ACCEL	G	-0.0	0.19	42	0.5	-0.5	0.9	-0.7		
PC	PSF	69.	13.1	11	107.	31.				
PT	PSF	95.	26.5	36	152.	49.	171.	34.		

RUN 102 VELOCITY 11.7 KT WAVE ENCOUNTERS 44
DRAG 8378. LB FAN DRAG 4389. LB
LCG 13.78 FT AIR FLOW 1217. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	7.5	3.15	38	11.4	3.9	13.8	1.8		
HEAVE	FT	2.2	0.28	33	2.6	1.9	2.9	1.8		
BOW ACCEL	G	-0.0	0.43	53	0.9	-0.6	1.3	-1.0	1.8	-1.1
CG ACCEL	G	-0.0	0.28	99	0.5	-0.4	0.9	-0.6	1.3	-0.8
STERN ACCEL	G	-0.0	0.41	83	0.8	-0.6	1.3	-1.0	1.7	-1.3
PC	PSF	71.	24.1	51	124.	24.	148.	-6.	167.	-49.
PT	PSF	95.	26.5	42	156.	51.	175.	38.		

RUN 104 VELOCITY 20.0 KT WAVE ENCOUNTERS 32
DRAG 7786. LB FAN DRAG 2741. LB
LCG 13.78 FT AIR FLOW 1205. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	4.7	2.96	26	8.5	1.0	10.5	-0.7		
HEAVE	FT	3.3	0.31	25	3.7	3.0	3.9	2.7		
BOW ACCEL	G	-0.0	0.64	52	0.9	-0.6	1.4	-1.1	1.9	-1.2
CG ACCEL	G	-0.0	0.33	69	0.5	-0.4	0.8	-0.6	1.0	-0.7
STERN ACCEL	G	-0.0	0.49	64	0.8	-0.5	1.4	-0.9	1.9	-1.3
PC	PSF	77.	36.5	69	136.	33.	187.	-7.	256.	-42.
PT	PSF	95.	39.4	56	160.	50.	208.	34.	256.	24.

TABLE 3-8

PERFORMANCE RESULTS IN SEA STATE 2

RUN 105 VELOCITY 30.0 KT WAVE ENCOUNTERS 23
DRAG 8505. LB FAN DRAG 1997. LB
LCG 13.78 FT AIR FLOW 1188. CFS

		MEAN	RMS OSC		AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	2.4	2.40	22	4.7	-0.3	7.0	-2.2		
HEAVE	FT	3.6	0.40	19	4.1	3.2	4.5	3.0		
BOW ACCEL	G	-0.0	0.71	38	1.0	-0.7	1.6	-1.1		
CG ACCEL	G	-0.0	0.44	51	0.6	-0.5	1.0	-0.7	1.5	-0.9
STERN ACCEL	G	-0.0	0.53	57	0.7	-0.5	1.3	-1.0	2.2	-1.5
PC	PSF	85.	40.8	53	151.	43.	202.	12.	290.	-22.
PT	PSF	94.	46.5	41	169.	50.	219.	25.		

RUN 94 VELOCITY 11.7 KT WAVE ENCOUNTERS 47
DRAG 10646. LB FAN DRAG 4214. LB
LCG 13.78 FT AIR FLOW 1225. CFS

		MEAN	RMS OSC		AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	4.9	2.83	31	8.6	1.0	10.2	-0.5		
HEAVE	FT	2.8	0.40	31	3.3	2.3	3.6	2.1		
BOW ACCEL	G	-0.0	0.38	41	0.7	-0.6	1.1	-0.9		
CG ACCEL	G	-0.0	0.22	54	0.4	-0.4	0.7	-0.5	0.9	-0.7
STERN ACCEL	G	-0.0	0.30	51	0.5	-0.5	0.8	-0.8	1.1	-1.1
PC	PSF	68.	16.9	22	118.	36.	138.	28.		
PT	PSF	155.	42.7	38	232.	94.	267.	77.		

RUN 93 VELOCITY 15.0 KT WAVE ENCOUNTERS 39
DRAG 8707. LB FAN DRAG 3980. LB
LCG 13.78 FT AIR FLOW 1188. CFS

		MEAN	RMS OSC		AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	6.8	2.61	37	9.8	3.2	11.9	1.7		
HEAVE	FT	3.1	0.35	30	3.5	2.6	3.8	2.4		
BOW ACCEL	G	-0.0	0.60	64	0.9	-0.7	1.7	-1.0	2.2	-1.2
CG ACCEL	G	-0.0	0.31	80	0.5	-0.5	0.9	-0.6	1.2	-0.7
STERN ACCEL	G	-0.0	0.53	87	0.8	-0.6	1.3	-1.2	1.7	-1.5
PC	PSF	85.	27.6	84	134.	50.	170.	32.	200.	15.
PT	PSF	153.	36.5	85	214.	106.	246.	84.	274.	72.

TABLE 3-9

PERFORMANCE RESULTS IN SEA STATE 2

RUN 92 VELOCITY 20.0 KT WAVE ENCOUNTERS 30
DRAG 7801. LB FAN DRAG 3018. LB
LCG 13.78 FT AIR FLOW 1186. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	4.8	2.69	32	8.1	1.6	10.4	-0.1		
HEAVE	FT	3.7	0.35	28	4.1	3.4	4.4	3.1		
BOW ACCEL	G	-0.0	0.78	49	1.5	-0.8	2.2	-1.2	2.8	-1.4
CG ACCEL	G	-0.0	0.37	70	0.6	-0.4	1.0	-0.7	1.3	-0.8
STERN ACCEL	G	-0.0	0.60	69	0.8	-0.7	1.5	-1.4	2.0	-1.6
PC	PSF	86.	31.2	75	135.	48.	174.	23.	212.	4.
PT	PSF	152.	48.1	75	221.	103.	274.	77.	333.	58.

RUN 91 VELOCITY 30.0 KT WAVE ENCOUNTERS 23
DRAG 8400. LB FAN DRAG 1939. LB
LCG 13.78 FT AIR FLOW 1193. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	2.2	3.54	21	6.6	-2.4	8.8	-4.1		
HEAVE	FT	4.2	0.47	20	4.7	3.7	5.2	3.6		
BOW ACCEL	G	-0.0	1.06	43	1.7	-0.7	2.7	-1.3		
CG ACCEL	G	-0.0	0.53	61	0.8	-0.5	1.3	-0.7	1.7	-0.9
STERN ACCEL	G	-0.0	0.90	55	1.2	-0.7	2.0	-1.7	2.8	-2.4
PC	PSF	82.	43.3	64	146.	37.	191.	-3.	237.	-55.
PT	PSF	153.	90.1	63	256.	86.	373.	47.	492.	29.

RUN 86 VELOCITY 15.0 KT WAVE ENCOUNTERS 38
DRAG 9576. LB FAN DRAG 3915. LB
LCG 13.78 FT AIR FLOW 1191. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	6.4	3.07	40	9.5	2.9	12.4	1.0		
HEAVE	FT	3.3	0.38	32	3.7	2.8	4.0	2.5		
BOW ACCEL	G	-0.0	0.66	58	1.2	-0.8	1.8	-1.2	2.3	-1.6
CG ACCEL	G	-0.0	0.31	81	0.5	-0.4	0.8	-0.6	1.1	-0.7
STERN ACCEL	G	-0.0	0.58	90	0.8	-0.7	1.5	-1.5	2.1	-1.9
PC	PSF	83.	36.4	88	146.	39.	188.	9.	214.	-20.
PT	PSF	198.	33.8	84	253.	153.	284.	127.	301.	106.

TABLE 3-10

PERFORMANCE RESULTS IN SEA STATE 2

RUN 88

VELOCITY 20.0 KT
DRAG 8176. LB
LCG 13.78 FT
WAVE ENCOUNTERS 32
FAN DRAG 2872. LB
AIR FLOW 1198. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	4.5	2.60	34	7.3	1.3	9.5	-0.2		
HEAVE	FT	3.9	0.38	29	4.4	3.5	4.7	3.2		
BOW ACCEL	G	-0.0	0.78	50	1.5	-0.8	2.3	-1.2	3.0	-1.5
CG ACCEL	G	-0.0	0.36	73	0.5	-0.4	0.9	-0.7	1.2	-0.8
STERN ACCEL	G	-0.0	0.63	82	0.8	-0.7	1.3	-1.5	1.9	-1.9
PC	PSF	81.	29.8	72	128.	44.	160.	22.	193.	11.
PT	PSF	197.	44.5	82	256.	151.	297.	121.	353.	97.

RUN 87

VELOCITY 30.0 KT
DRAG 8505. LB
LCG 13.78 FT
WAVE ENCOUNTERS 22
FAN DRAG 2056. LB
AIR FLOW 1181. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	2.2	3.22	24	6.0	-1.8	8.4	-3.5		
HEAVE	FT	4.4	0.42	17	4.9	3.8	5.3	3.6		
BOW ACCEL	G	-0.0	1.04	50	1.6	-0.5	2.6	-1.3	3.1	-1.4
CG ACCEL	G	0.0	0.50	59	0.8	-0.4	1.3	-0.8	1.7	-0.9
STERN ACCEL	G	-0.0	0.89	51	1.0	-0.8	2.1	-1.7	3.0	-2.4
PC	PSF	88.	46.5	61	162.	41.	215.	6.	259.	-9.
PT	PSF	195.	79.7	61	289.	126.	395.	88.	497.	69.

RUN 77

VELOCITY 0.0 KT
DRAG 719. LB
LCG 13.78 FT
WAVE ENCOUNTERS 108
FAN DRAG LB
AIR FLOW 1213. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	2.4	1.81	92	4.7	0.2	6.1	-1.2	7.0	-2.0
HEAVE	FT	3.0	0.27	71	3.4	2.6	3.5	2.4	3.6	2.3
BOW ACCEL	G	-0.0	0.19	435	0.4	-0.3	0.5	-0.4	0.6	-0.5
CG ACCEL	G	-0.0	0.11	213	0.3	-0.2	0.4	-0.3	0.4	-0.3
STERN ACCEL	G	-0.0	0.09	66	0.2	-0.3	0.3	-0.3	0.4	-0.4
PC	PSF	74.	12.3	266	103.	53.	112.	47.	120.	43.
PT	PSF	225.	11.9	178	255.	197.	262.	192.	268.	187.

TABLE 3-11

PERFORMANCE RESULTS IN SEA STATE 2

RUN 78 VELOCITY 5.0 KT WAVE ENCOUNTERS 76
DRAG 2066. LB FAN DRAG 10199. LB
LCG 13.78 FT AIR FLOW 1217. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	2.1	2.56	67	5.4	-0.8	7.3	-2.5	8.4	-3.3
HEAVE	FT	2.8	0.35	51	3.3	2.3	3.6	2.1	3.8	1.9
BOW ACCEL	G	-0.0	0.25	133	0.4	-0.4	0.6	-0.7	0.9	-0.9
CG ACCEL	G	-0.0	0.14	95	0.4	-0.3	0.5	-0.4	0.7	-0.5
STERN ACCEL	G	-0.0	0.21	94	0.5	-0.4	1.0	-0.5	1.4	-0.7
PC	PSF	71.	28.4	114	149.	36.	232.	11.	311.	-18.
PT	PSF	227.	13.2	72	262.	198.	277.	192.	287.	188.

RUN 79 VELOCITY 7.5 KT WAVE ENCOUNTERS 58
DRAG 4717. LB FAN DRAG 6896. LB
LCG 13.78 FT AIR FLOW 1217. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	2.2	2.47	46	5.5	-0.7	7.3	-2.7	8.5	-3.9
HEAVE	FT	2.8	0.41	41	3.3	2.3	3.7	2.0		
BOW ACCEL	G	-0.0	0.31	133	0.4	-0.4	0.7	-0.7	0.9	-0.9
CG ACCEL	G	-0.0	0.15	62	0.3	-0.3	0.5	-0.4	0.6	-0.5
STERN ACCEL	G	-0.0	0.21	81	0.4	-0.4	0.7	-0.5	0.9	-0.6
PC	PSF	72.	30.6	98	143.	41.	208.	17.	314.	-11.
PT	PSF	228.	15.7	73	263.	198.	278.	189.	296.	181.

RUN 80 VELOCITY 10.0 KT WAVE ENCOUNTERS 50
DRAG 13776. LB FAN DRAG 7363. LB
LCG 13.78 FT AIR FLOW 1120. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	-0.1	2.06	37	2.3	-2.5	4.2	-3.7		
HEAVE	FT	2.4	0.36	33	2.8	1.9	3.2	1.7		
BOW ACCEL	G	-0.0	0.23	63	0.4	-0.4	0.8	-0.6	1.1	-0.8
CG ACCEL	G	-0.0	0.13	39	0.4	-0.3	0.6	-0.4		
STERN ACCEL	G	-0.0	0.17	46	0.4	-0.4	0.6	-0.5	0.8	-0.6
PC	PSF	111.	49.9	98	195.	60.	280.	16.	361.	-23.
PT	PSF	241.	29.8	46	296.	195.	328.	180.	351.	169.

TABLE 3-12

PERFORMANCE RESULTS IN SEA STATE 2

RUN 81 — VELOCITY 11.7 KT — WAVE ENCOUNTERS 45
DRAG 16681. LB — FAN DRAG 4403. LB
LCG 13.78 FT — AIR FLOW 1217. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	3.0	2.39	30	6.3	-0.0	8.2	-1.3		
HEAVE	FT	2.6	0.41	31	3.1	2.1	3.5	1.9		
BOW ACCEL	G	-0.0	0.32	54	0.5	-0.5	0.9	-1.0	1.5	-1.2
CG ACCEL	G	-0.0	0.20	38	0.4	-0.4	0.8	-0.7		
STERN ACCEL	G	-0.0	0.27	50	0.6	-0.4	1.0	-0.8	1.8	-1.2
PC	PSF	72.	28.0	57	129.	45.	196.	29.	275.	21.
PT	PSF	243.	41.4	45	304.	182.	352.	154.		

RUN 85 — VELOCITY 15.0 KT — WAVE ENCOUNTERS 39
DRAG 9928. LB — FAN DRAG 3944. LB
LCG 13.78 FT — AIR FLOW 1191. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	6.2	2.96	41	9.0	3.0	12.1	0.8		
HEAVE	FT	3.2	0.39	34	3.7	2.8	4.0	2.6		
BOW ACCEL	G	-0.0	0.66	63	1.1	-0.7	1.9	-1.1	2.5	-1.4
CG ACCEL	G	-0.0	0.32	86	0.5	-0.4	0.8	-0.6	1.0	-0.7
STERN ACCEL	G	-0.0	0.57	97	0.8	-0.7	1.4	-1.4	1.8	-1.9
PC	PSF	84.	38.1	93	150.	41.	198.	15.	226.	-4.
PT	PSF	239.	35.7	86	290.	189.	321.	170.	348.	162.

RUN 83 — VELOCITY 20.0 KT — WAVE ENCOUNTERS 32
DRAG 8700. LB — FAN DRAG 2952. LB
LCG 13.78 FT — AIR FLOW 1191. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	4.4	2.57	35	6.9	1.4	9.4	-0.3		
HEAVE	FT	3.9	0.38	27	4.3	3.5	4.6	3.2		
BOW ACCEL	G	-0.0	0.78	54	1.4	-0.7	2.3	-1.1	3.0	-1.3
CG ACCEL	G	-0.0	0.36	71	0.6	-0.4	1.0	-0.6	1.2	-0.8
STERN ACCEL	G	-0.0	0.60	82	0.7	-0.7	1.2	-1.5	1.6	-1.9
PC	PSF	84.	35.2	80	139.	40.	175.	15.	204.	-3.
PT	PSF	240.	47.6	80	297.	186.	346.	163.	418.	147.

TABLE 3-13

PERFORMANCE RESULTS IN SEA STATE 2

RUN 84 VELOCITY 30.0 KT WAVE ENCOUNTERS 21
DRAG 9246. LB FAN DRAG 1968. LB
LCG 13.78 FT AIR FLOW 1191. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	2.5	3.70	22	6.7	-2.1	9.8	-4.4		
HEAVE	FT	4.3	0.49	18	4.8	3.7	5.5	3.5		
BOW ACCEL	G	-0.0	1.13	47	1.8	-0.8	3.0	-1.4	4.0	-1.7
CG ACCEL	G	-0.0	0.53	64	0.8	-0.5	1.3	-0.8	1.9	-1.0
STERN ACCEL	G	-0.0	1.01	55	1.2	-0.8	2.5	-1.8	3.9	-2.7
PC	PSF	84.	54.3	64	166.	37.	233.	4.	322.	-14.
PT	PSF	254.	94.7	60	355.	165.	493.	133.	641.	116.

RUN 89 VELOCITY 30.0 KT WAVE ENCOUNTERS 23
DRAG 9725. LB FAN DRAG 2034. LB
LCG 13.78 FT AIR FLOW 1183. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	2.3	2.85	25	5.7	-1.4	7.9	-3.2		
HEAVE	FT	4.5	0.37	21	4.9	4.0	5.3	3.8		
BOW ACCEL	G	-0.0	1.19	42	2.1	-0.8	3.3	-1.5		
CG ACCEL	G	-0.0	0.51	60	0.8	-0.5	1.3	-0.8	1.7	-1.0
STERN ACCEL	G	-0.0	0.95	59	1.0	-0.9	2.0	-1.8	3.1	-2.6
PC	PSF	87.	51.7	62	162.	41.	229.	2.	283.	-13.
PT	PSF	307.	107.3	58	412.	214.	566.	180.	756.	150.

RUN 111 VELOCITY 11.7 KT WAVE ENCOUNTERS 45
DRAG 8206. LB FAN DRAG 6430. LB
LCG 13.78 FT AIR FLOW 1759. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	7.6	3.24	35	11.8	3.6	13.9	1.5		
HEAVE	FT	2.2	0.29	33	2.6	1.9	2.9	1.8		
BOW ACCEL	G	-0.0	0.43	54	0.8	-0.6	1.3	-1.0	2.1	-1.2
CG ACCEL	G	-0.0	0.28	97	0.5	-0.4	0.9	-0.6	1.4	-0.7
STERN ACCEL	G	-0.0	0.39	74	0.8	-0.6	1.3	-1.0	1.8	-1.4
PC	PSF	72.	19.3	39	115.	32.	137.	11.		
PT	PSF	95.	26.8	44	156.	50.	177.	39.		

TABLE 3-14

PERFORMANCE RESULTS IN SEA STATE 2

RUN 112

VELOCITY 30.0 KT — WAVE ENCOUNTERS 23
DRAG 8101. LB — FAN DRAG 3040. LB
LCG 13.78 FT — AIR FLOW 1701. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	2.5	2.31	19	5.3	-0.3	7.4	-1.8		
HEAVE	FT	3.6	0.41	17	4.1	3.2	4.5	2.9		
BOW ACCEL	G	-0.0	0.70	45	0.8	-0.6	1.5	-1.1		
CG ACCEL	G	-0.0	0.41	55	0.6	-0.4	0.9	-0.7	1.3	-0.8
STERN ACCEL	G	-0.0	0.46	53	0.6	-0.5	1.1	-1.0	1.6	-1.3
PC	PSF	91.	43.5	58	152.	45.	207.	12.	317.	-19.
PT	PSF	94.	46.6	41	162.	48.	214.	22.		

RUN 109

VELOCITY 11.7 KT — WAVE ENCOUNTERS 46
DRAG 9418. LB — FAN DRAG 5497. LB
LCG 13.78 FT — AIR FLOW 1796. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	6.3	3.33	34	10.3	2.2	13.1	-0.2		
HEAVE	FT	2.9	0.35	34	3.3	2.4	3.6	2.2		
BOW ACCEL	G	-0.0	0.43	42	0.8	-0.7	1.1	-1.1		
CG ACCEL	G	-0.0	0.25	68	0.5	-0.4	0.7	-0.5	1.0	-0.7
STERN ACCEL	G	-0.0	0.42	66	0.7	-0.6	1.0	-1.1	1.4	-1.4
PC	PSF	61.	18.8	35	108.	25.	133.	11.		
PT	PSF	152.	32.9	49	216.	101.	244.	88.	271.	79.

RUN 110

VELOCITY 30.0 KT — WAVE ENCOUNTERS 23
DRAG 8288. LB — FAN DRAG 2880. LB
LCG 13.78 FT — AIR FLOW 1720. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	2.5	3.70	22	7.2	-2.5	9.4	-4.2		
HEAVE	FT	4.1	0.46	21	4.6	3.6	5.2	3.4		
BOW ACCEL	G	-0.0	1.09	42	1.7	-0.6	2.9	-1.3		
CG ACCEL	G	-0.0	0.56	51	0.9	-0.5	1.5	-0.8	2.1	-0.9
STERN ACCEL	G	-0.0	0.95	52	1.3	-0.8	2.2	-2.0	3.0	-2.8
PC	PSF	85.	49.1	57	163.	33.	213.	-4.	265.	-31.
PT	PSF	151.	92.1	61	257.	78.	385.	41.	495.	24.

TABLE 3-15

PERFORMANCE RESULTS IN SEA STATE 2

RUN 108 — VELOCITY 11.7 KT — WAVE ENCOUNTERS 42
DRAG 11934. LB — FAN DRAG 6211. LB
LCG 13.78 FT — AIR FLOW 1769. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	5.8	2.73	30	9.6	2.2	11.1	0.4		
HEAVE	FT	3.0	0.46	31	3.6	2.5	4.0	2.2		
BOW ACCEL	G	-0.0	0.40	44	0.7	-0.7	1.2	-1.0		
CG ACCEL	G	-0.0	0.24	52	0.5	-0.4	0.8	-0.6	1.1	-0.8
STERN ACCEL	G	-0.0	0.31	53	0.6	-0.5	1.0	-0.8	1.7	-1.1
PC	PSF	70.	16.7	26	116.	38.	138.	30.		
PT	PSF	231.	28.4	42	294.	182.	328.	168.		

RUN 107 — VELOCITY 20.0 KT — WAVE ENCOUNTERS 31
DRAG 8445. LB — FAN DRAG 4272. LB
LCG 13.78 FT — AIR FLOW 1725. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	4.8	2.55	31	7.8	1.4	9.8	0.0		
HEAVE	FT	3.9	0.38	28	4.3	3.5	4.6	3.2		
BOW ACCEL	G	-0.0	0.77	48	1.5	-0.8	2.4	-1.2	3.0	-1.3
CG ACCEL	G	-0.0	0.36	60	0.6	-0.5	1.0	-0.7	1.4	-0.8
STERN ACCEL	G	-0.0	0.60	83	0.7	-0.7	1.3	-1.5	1.7	-1.9
PC	PSF	84.	26.2	63	129.	50.	167.	34.	215.	26.
PT	PSF	236.	46.7	74	296.	181.	346.	161.	410.	147.

RUN 106 — VELOCITY 30.0 KT — WAVE ENCOUNTERS 24
DRAG 8685. LB — FAN DRAG 2894. LB
LCG 13.78 FT — AIR FLOW 1720. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	2.6	3.30	23	6.5	-1.5	8.7	-3.6		
HEAVE	FT	4.3	0.45	19	4.8	3.8	5.3	3.6		
BOW ACCEL	G	-0.0	1.07	42	1.8	-0.8	2.7	-1.5		
CG ACCEL	G	-0.0	0.52	57	0.8	-0.5	1.4	-0.8	1.8	-1.0
STERN ACCEL	G	-0.0	0.89	53	1.1	-0.8	2.2	-1.7	3.4	-2.3
PC	PSF	85.	50.0	55	170.	37.	232.	-6.	310.	-52.
PT	PSF	247.	82.7	68	335.	168.	437.	135.	547.	112.

TABLE 3-16

PERFORMANCE RESULTS IN SEA STATE 2

RUN 404

VELOCITY 10.0 KT — WAVE ENCOUNTERS 55
DRAG 7726. LB — FAN DRAG 4723. LB
LCG 14.53 FT — AIR FLOW 1232. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	5.3	2.21	36	7.7	2.6	9.8	1.1		
HEAVE	FT	1.9	0.38	33	2.4	1.4	2.7	1.2		
BOW ACCEL.	G	-0.0	0.28	61	0.5	-0.4	0.7	-0.6	0.9	-0.8
CG ACCEL.	G	-0.0	0.16	52	0.3	-0.3	0.4	-0.4	0.5	-0.5
STERN ACCEL.	G	-0.0	0.15	40	0.4	-0.3	0.6	-0.4		
PC	PSF	65.	15.5	36	111.	41.	149.	28.		
PT	PSF	81.	21.3	35	131.	48.	148.	38.		

RUN 394

VELOCITY 10.0 KT — WAVE ENCOUNTERS 54
DRAG 9867. LB — FAN DRAG 5576. LB
LCG 14.53 FT — AIR FLOW 1203. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	3.4	2.93	36	7.1	-0.3	9.6	-2.3		
HEAVE	FT	2.5	0.41	32	3.0	2.0	3.4	1.7		
BOW ACCEL.	G	-0.0	0.33	52	0.5	-0.5	0.7	-0.8	0.9	-0.9
CG ACCEL.	G	-0.0	0.16	47	0.3	-0.3	0.4	-0.4	0.4	-0.5
STERN ACCEL.	G	-0.0	0.19	37	0.4	-0.4	0.5	-0.5		
PC	PSF	78.	66.9	88	186.	50.	328.	15.	407.	8.
PT	PSF	121.	28.9	39	175.	78.	198.	67.		

RUN 415

VELOCITY 11.7 KT — WAVE ENCOUNTERS 50
DRAG 10766. LB — FAN DRAG 5241. LB
LCG 14.53 FT — AIR FLOW 1181. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	9.7	1.65	32	11.7	7.8	13.0	6.4		
HEAVE	FT	1.1	0.33	29	1.6	0.7	1.9	0.5		
BOW ACCEL.	G	-0.0	0.26	51	0.4	-0.4	0.6	-0.6	0.8	-0.7
CG ACCEL.	G	-0.0	0.15	36	0.3	-0.3	0.4	-0.4		
STERN ACCEL.	G	-0.0	0.09	12	0.3	-0.3				
PC	PSF	88.	53.9	164	162.	49.	254.	6.	341.	-32.
PT	PSF	66.	21.1	29	116.	32.	134.	21.		

TABLE 3-17

PERFORMANCE RESULTS IN SEA STATE 2

RUN 413

VELOCITY 11.7 KT
DRAG 10257. LB
LCG 14.53 FT
WAVE ENCOUNTERS 51
FAN DRAG 5285. LB
AIR FLOW 1179. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	9.9	1.87	33	12.1	7.7	13.7	6.0		
HEAVE	FT	1.4	0.33	29	1.8	1.0	2.1	0.8		
BOW ACCEL.	G	-0.0	0.30	69	0.4	-0.4	0.7	-0.7	0.9	-0.8
CG ACCEL.	G	-0.0	0.18	61	0.3	-0.3	0.5	-0.4	0.6	-0.5
STERN ACCEL.	G	-0.0	0.13	33	0.4	-0.3	0.6	-0.3		
PC	PSF	89.	91.2	140	238.	52.	407.	-8.	477.	-47.
PT	PSF	69.	21.8	35	116.	31.	134.	22.		

RUN 403

VELOCITY 11.7 KT
DRAG 9448. LB
LCG 14.53 FT
WAVE ENCOUNTERS 49
FAN DRAG 4775. LB
AIR FLOW 1203. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	9.0	2.45	35	11.9	6.1	13.7	4.1		
HEAVE	FT	1.8	0.33	34	2.3	1.5	2.6	1.2		
BOW ACCEL.	G	-0.0	0.36	81	0.5	-0.4	0.8	-0.7	1.0	-0.9
CG ACCEL.	G	-0.0	0.21	82	0.4	-0.3	0.5	-0.5	0.6	-0.6
STERN ACCEL.	G	-0.0	0.22	61	0.5	-0.3	0.8	-0.5	1.1	-0.5
PC	PSF	79.	46.5	93	172.	45.	298.	16.	429.	-14.
PT	PSF	83.	23.7	39	134.	42.	158.	34.		

RUN 395

VELOCITY 11.7 KT
DRAG 8864. LB
LCG 14.53 FT
WAVE ENCOUNTERS 47
FAN DRAG 4650. LB
AIR FLOW 1208. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	8.2	3.55	35	12.8	4.0	15.5	1.5		
HEAVE	FT	2.4	0.34	34	2.8	2.0	3.1	1.7		
BOW ACCEL.	G	-0.0	0.47	81	0.6	-0.5	1.2	-1.0	1.5	-1.2
CG ACCEL.	G	-0.0	0.25	87	0.5	-0.4	0.8	-0.5	1.1	-0.6
STERN ACCEL.	G	-0.0	0.38	85	0.6	-0.4	1.0	-0.8	1.5	-1.0
PC	PSF	76.	26.8	79	127.	40.	162.	14.	198.	-7.
PT	PSF	120.	29.5	64	180.	78.	213.	62.	237.	51.

TABLE 3-18

PERFORMANCE RESULTS IN SEA STATE 2

RUN 380 VELOCITY 11.7 KT WAVE ENCOUNTERS 46
DRAG 8730. LB FAN DRAG 4359. LB
LCG 14.53 FT AIR FLOW 1220. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	7.8	3.70	35	12.8	3.3	15.4	1.0		
HEAVE	FT	2.5	0.32	34	3.0	2.2	3.3	1.9		
BOW ACCEL	G	-0.0	0.51	79	0.8	-0.5	1.4	-1.0	2.2	-1.3
CG ACCEL	G	-0.0	0.28	94	0.5	-0.4	0.9	-0.6	1.3	-0.7
STERN ACCEL	G	-0.0	0.38	80	0.6	-0.4	1.1	-0.8	1.5	-1.1
PC	PSF	71.	32.0	82	127.	32.	175.	3.	238.	-26.
PT	PSF	120.	27.2	102	166.	88.	198.	69.	223.	60.

RUN 405 VELOCITY 15.0 KT WAVE ENCOUNTERS 45
DRAG 10152. LB FAN DRAG 3805. LB
LCG 14.53 FT AIR FLOW 1198. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	8.8	2.51	32	11.8	5.8	13.8	4.1		
HEAVE	FT	2.4	0.35	32	2.7	2.0	3.1	1.7		
BOW ACCEL	G	-0.0	0.47	68	0.6	-0.6	1.1	-0.9	1.5	-1.0
CG ACCEL	G	-0.0	0.25	71	0.4	-0.4	0.6	-0.5	0.8	-0.6
STERN ACCEL	G	-0.0	0.24	46	0.6	-0.3	0.9	-0.4	1.2	-0.5
PC	PSF	80.	79.7	116	213.	30.	394.	-26.	472.	-68.
PT	PSF	93.	29.1	48	141.	43.	179.	29.	213.	24.

RUN 381 VELOCITY 15.0 KT WAVE ENCOUNTERS 42
DRAG 9441. LB FAN DRAG 3615. LB
LCG 14.53 FT AIR FLOW 1208. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	7.6	3.24	34	11.6	3.6	14.0	1.7		
HEAVE	FT	2.9	0.38	33	3.4	2.5	3.7	2.3		
BOW ACCEL	G	-0.0	0.62	63	0.9	-0.7	1.6	-1.0	1.9	-1.2
CG ACCEL	G	-0.0	0.31	79	0.5	-0.4	0.8	-0.6	1.0	-0.7
STERN ACCEL	G	-0.0	0.46	60	0.9	-0.5	1.5	-0.9	1.8	-1.1
PC	PSF	76.	41.0	78	147.	26.	218.	-12.	316.	-58.
PT	PSF	120.	37.9	89	181.	82.	220.	58.	256.	46.

TABLE 3-19

PERFORMANCE RESULTS IN SEA STATE 2

RUN 382 VELOCITY 20.0 KT WAVE ENCOUNTERS 41
DRAG 8325. LB FAN DRAG 2802. LB
LCG 14.53 FT AIR FLOW 1203. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	5.2	3.18	28	9.2	1.2	11.5	-0.3		
HEAVE	FT	3.7	0.38	29	4.1	3.3	4.4	3.0		
BOW ACCEL	G	-0.0	0.74	55	1.2	-0.6	2.0	-1.0	2.7	-1.3
CG ACCEL	G	-0.0	0.37	74	0.6	-0.5	1.0	-0.7	1.3	-0.8
STERN ACCEL	G	-0.0	0.51	59	0.8	-0.6	1.5	-0.9	2.0	-1.2
PC	PSF	79.	39.9	74	140.	32.	203.	-6.	277.	-56.
PT	PSF	119.	47.4	69	199.	69.	252.	48.	305.	35.

RUN 414 VELOCITY 30.0 KT WAVE ENCOUNTERS 33
DRAG 11904. LB FAN DRAG 2158. LB
LCG 14.53 FT AIR FLOW 1169. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	3.9	1.66	20	5.6	2.1	6.9	0.8		
HEAVE	FT	3.2	0.40	18	3.7	2.8	4.0	2.5		
BOW ACCEL	G	-0.0	0.57	42	0.8	-0.5	1.3	-0.9		
CG ACCEL	G	-0.0	0.35	39	0.5	-0.4	0.9	-0.6		
STERN ACCEL	G	-0.0	0.30	34	0.5	-0.4	0.9	-0.6		
PC	PSF	93.	68.8	77	165.	21.	261.	-37.	356.	-111.
PT	PSF	73.	40.1	30	148.	33.	192.	12.		

RUN 412 VELOCITY 30.0 KT WAVE ENCOUNTERS 31
DRAG 9598. LB FAN DRAG 2296. LB
LCG 14.53 FT AIR FLOW 1147. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	3.9	2.01	21	5.9	1.8	7.6	0.6		
HEAVE	FT	3.4	0.46	18	3.9	2.9	4.3	2.7		
BOW ACCEL	G	-0.0	0.63	41	0.9	-0.6	1.6	-1.1		
CG ACCEL	G	-0.0	0.41	44	0.6	-0.4	1.1	-0.7		
STERN ACCEL	G	-0.0	0.39	48	0.6	-0.4	1.1	-0.6		
PC	PSF	191.	75.2	86	191.	37.	308.	-20.	420.	-65.
PT	PSF	81.	40.3	34	157.	42.	203.	21.		

TABLE 3-20

PERFORMANCE RESULTS IN SEA STATE 2

RUN 402 — VELOCITY 30.0 KT — WAVE ENCOUNTERS 36
DRAG 9261. LB — FAN DRAG 2325. LB
LCG 14.53 FT — AIR FLOW 1142. CFS

		MEAN	RMS OSC		AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	3.8	2.16	20	6.2	1.4	7.9	0.2		
HEAVE	FT	3.4	0.44	18	3.9	3.0	4.4	2.7		
BOW ACCEL	G	-0.0	0.70	44	0.9	-0.6	1.6	-1.2		
CG ACCEL	G	-0.0	0.42	52	0.5	-0.5	1.0	-0.8	1.4	-1.0
STERN ACCEL	G	-0.0	0.38	54	0.5	-0.4	1.0	-0.7	1.5	-1.0
PC	PSF	103.	85.1	75	197.	32.	339.	-30.	445.	-89.
PT	PSF	82.	47.2	37	160.	43.	216.	21.		

RUN 383 — VELOCITY 30.0 KT — WAVE ENCOUNTERS 33
DRAG 8393. LB — FAN DRAG 2005. LB
LCG 14.53 FT — AIR FLOW 1188. CFS

		MEAN	RMS OSC		AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	3.0	3.26	19	6.9	-0.7	9.9	-2.6		
HEAVE	FT	4.0	0.50	21	4.4	3.5	5.1	3.2		
BOW ACCEL	G	-0.0	0.88	44	1.4	-0.6	2.2	-1.2		
CG ACCEL	G	-0.0	0.55	52	0.9	-0.5	1.5	-0.8	1.9	-1.0
STERN ACCEL	G	-0.0	0.61	54	0.9	-0.5	1.5	-1.2	1.8	-1.6
PC	PSF	85.	51.8	67	165.	41.	238.	0.	327.	-22.
PT	PSF	118.	67.0	55	220.	68.	301.	33.	360.	17.

RUN 391 — VELOCITY 5.0 KT — WAVE ENCOUNTERS 75
DRAG 2096. LB — FAN DRAG 10643. LB
LCG 13.78 FT — AIR FLOW 1210. CFS

		MEAN	RMS OSC		AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	2.3	2.94	63	6.2	-1.3	8.0	-3.3	9.1	-4.1
HEAVE	FT	2.3	0.34	51	2.7	1.9	3.0	1.6	3.2	1.5
BOW ACCEL	G	-0.0	0.21	98	0.3	-0.4	0.5	-0.6	0.6	-0.8
CG ACCEL	G	-0.0	0.11	65	0.3	-0.3	0.5	-0.4	0.6	-0.4
STERN ACCEL	G	-0.0	0.18	65	0.6	-0.3	0.9	-0.4	1.2	-0.5
PC	PSF	74.	34.2	108	179.	40.	294.	23.	372.	10.
PT	PSF	118.	14.7	45	162.	85.	178.	74.	188.	64.

TABLE 3-21

PERFORMANCE RESULTS IN SEA STATE 2

RUN 392 — VELOCITY 7.5 KT — WAVE ENCOUNTERS 64
DRAG 5548. LB — FAN DRAG 7115. LB
LCG 13.78 FT — AIR FLOW 1210. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	2.3	2.61	49	5.2	-0.9	7.4	-2.9	9.0	-4.4
HEAVE	FT	2.4	0.43	40	3.0	1.9	3.4	1.6		
BOW ACCEL.	G	-0.0	0.31	83	0.5	-0.4	0.8	-0.7	1.0	-0.8
CG ACCEL.	G	-0.0	0.15	52	0.3	-0.3	0.4	-0.4	0.4	-0.4
STERN ACCEL.	G	-0.0	0.17	44	0.3	-0.4	0.5	-0.6		
PC	PSF	74.	25.1	60	143.	37.	195.	6.	244.	-11.
PT	PSF	119.	20.9	47	167.	81.	186.	72.	204.	68.

RUN 396 — VELOCITY 14.0 KT — WAVE ENCOUNTERS 55
DRAG 10646. LB — FAN DRAG 6356. LB
LCG 13.78 FT — AIR FLOW 1171. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	0.8	2.65	37	4.0	-2.5	5.8	-4.1		
HEAVE	FT	2.2	0.37	32	2.6	1.7	2.9	1.5		
BOW ACCEL.	G	-0.0	0.27	45	0.4	-0.4	0.6	-0.6		
CG ACCEL.	G	-0.0	0.13	32	0.3	-0.3	0.3	-0.4		
STERN ACCEL.	G	-0.0	0.18	33	0.3	-0.4	0.4	-0.6		
PC	PSF	91.	72.4	102	221.	80.	324.	20.	395.	8.
PT	PSF	125.	31.4	37	179.	76.	201.	65.		

RUN 410 — VELOCITY 11.7 KT — WAVE ENCOUNTERS 51
DRAG 9538. LB — FAN DRAG 4476. LB
LCG 13.78 FT — AIR FLOW 1215. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	6.0	1.93	36	8.1	3.8	10.0	2.4		
HEAVE	FT	1.4	0.34	28	1.8	0.9	2.1	0.7		
BOW ACCEL.	G	-0.0	0.27	48	0.4	-0.4	0.7	-0.7	0.8	-0.8
CG ACCEL.	G	-0.0	0.16	49	0.3	-0.3	0.4	-0.4	0.5	-0.5
STERN ACCEL.	G	-0.0	0.13	34	0.3	-0.3	0.4	-0.4		
PC	PSF	73.	35.9	69	141.	43.	228.	24.	323.	13.
PT	PSF	87.	28.3	35	141.	42.	165.	30.		

TABLE 3-22

PERFORMANCE RESULTS IN SEA STATE 2

RUN 375

VELOCITY 11.7 KT — WAVE ENCOUNTERS 53
DRAG 8557. LB — FAN DRAG 4512. LB
LCG 13.78 FT — AIR FLOW 1213. CFS

		MEAN	RMS OSC		AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	6.6	3.48	37	11.2	2.5	13.2	0.2		
HEAVE	FT	2.6	0.32	35	3.0	2.2	3.3	2.0		
BOW ACCEL.	G	-0.0	0.45	90	0.6	-0.4	1.0	-0.9	1.3	-1.2
CG ACCEL.	G	-0.0	0.25	103	0.5	-0.3	0.7	-0.5	1.1	-0.6
STERN ACCEL.	G	-0.0	0.38	87	0.6	-0.5	0.9	-0.9	1.2	-1.1
PC	PSF	73.	26.8	90	120.	37.	148.	16.	180.	2.
PT	PSF	121.	30.5	103	167.	88.	200.	69.	226.	58.

RUN 376

VELOCITY 15.0 KT — WAVE ENCOUNTERS 42
DRAG 8917. LB — FAN DRAG 3601. LB
LCG 13.78 FT — AIR FLOW 1210. CFS

		MEAN	RMS OSC		AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	7.0	3.04	34	10.9	3.2	13.1	1.5		
HEAVE	FT	2.9	0.32	31	3.3	2.5	3.5	2.2		
BOW ACCEL.	G	-0.0	0.57	61	0.9	-0.6	1.4	-1.0	1.8	-1.3
CG ACCEL.	G	-0.0	0.29	84	0.5	-0.4	0.8	-0.6	1.0	-0.7
STERN ACCEL.	G	-0.0	0.47	76	0.8	-0.5	1.5	-0.9	1.9	-1.2
PC	PSF	76.	40.9	86	139.	25.	192.	-10.	253.	-47.
PT	PSF	121.	37.6	94	175.	80.	217.	59.	250.	46.

RUN 377

VELOCITY 20.0 KT — WAVE ENCOUNTERS 36
DRAG 7869. LB — FAN DRAG 2887. LB
LCG 13.78 FT — AIR FLOW 1196. CFS

		MEAN	RMS OSC		AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	4.8	2.95	28	8.2	1.3	10.8	-0.4		
HEAVE	FT	3.6	0.37	30	4.0	3.3	4.4	3.0		
BOW ACCEL.	G	-0.0	0.68	51	1.1	-0.7	1.7	-1.1	2.1	-1.3
CG ACCEL.	G	-0.0	0.36	76	0.5	-0.4	0.9	-0.7	1.1	-0.8
STERN ACCEL.	G	-0.0	0.50	63	0.8	-0.5	1.3	-0.9	1.6	-1.1
PC	PSF	81.	37.4	76	141.	32.	182.	-5.	225.	-46.
PT	PSF	120.	46.2	82	184.	77.	235.	51.	284.	38.

TABLE 3-23

PERFORMANCE RESULTS IN SEA STATE 2

RUN 378

VELOCITY 30.0 KT — WAVE ENCOUNTERS 36
DRAG 8527. LB — FAN DRAG 1976. LB
LCG 13.78 FT — AIR FLOW 1191. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	2.4	3.03	19	6.1	-1.3	8.6	-3.2		
HEAVE	FT	3.9	0.46	18	4.4	3.4	5.0	3.2		
BOW ACCEL	G	-0.0	0.84	49	1.2	-0.5	2.1	-1.1	3.1	-1.4
CG ACCEL	G	-0.0	0.52	55	0.8	-0.5	1.4	-0.8	1.9	-0.9
STERN ACCEL	G	0.0	0.66	55	1.0	-0.6	1.5	-1.4	2.0	-2.1
PC	PSF	84.	51.7	57	153.	29.	199.	-18.	239.	-56.
PT	PSF	119.	70.8	59	210.	72.	308.	33.	394.	15.

RUN 411

VELOCITY 30.0 KT — WAVE ENCOUNTERS 27
DRAG 8857. LB — FAN DRAG 2034. LB
LCG 13.78 FT — AIR FLOW 1183. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	2.6	3.52	18	6.8	-1.8	10.2	-3.4		
HEAVE	FT	3.8	0.50	22	4.3	3.4	4.7	3.1		
BOW ACCEL	G	-0.0	0.88	49	1.1	-0.5	2.1	-1.3	3.2	-1.8
CG ACCEL	G	-0.0	0.51	57	0.8	-0.4	1.4	-0.7	1.9	-0.9
STERN ACCEL	G	-0.0	0.73	58	1.0	-0.6	1.9	-1.4	3.2	-2.1
PC	PSF	87.	65.2	68	166.	34.	247.	-25.	354.	-102.
PT	PSF	120.	73.3	52	215.	68.	303.	40.	388.	22.

RUN 384

VELOCITY 11.7 KT — WAVE ENCOUNTERS 50
DRAG 8894. LB — FAN DRAG 3500. LB
LCG 13.03 FT — AIR FLOW 1249. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	5.6	3.40	34	9.9	1.5	12.4	-0.4		
HEAVE	FT	2.4	0.31	29	2.9	2.1	3.2	1.9		
BOW ACCEL	G	-0.0	0.39	72	0.6	-0.4	1.0	-0.8	1.3	-1.0
CG ACCEL	G	-0.0	0.23	85	0.4	-0.3	0.7	-0.5	1.0	-0.6
STERN ACCEL	G	-0.0	0.35	77	0.6	-0.5	1.0	-0.9	1.4	-1.2
PC	PSF	56.	18.0	57	93.	25.	115.	8.	147.	-6.
PT	PSF	122.	38.5	54	191.	75.	231.	56.	267.	47.

TABLE 3-24

PERFORMANCE RESULTS IN SEA STATE 2

RUN 385 VELOCITY 15.0 KT WAVE ENCOUNTERS 44
DRAG 8625. LB FAN DRAG 3011. LB
LCG 13.03 FT AIR FLOW 1237. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	6.6	3.00	34	10.1	3.1	12.6	1.3		
HEAVE	FT	2.8	0.35	32	3.2	2.4	3.5	2.1		
BOW ACCEL	G	-0.0	0.53	53	0.9	-0.6	1.3	-1.0	1.8	-1.2
CG ACCEL	G	-0.0	0.27	78	0.5	-0.4	0.8	-0.6	1.0	-0.7
STERN ACCEL	G	-0.0	0.42	83	0.7	-0.5	1.1	-0.9	1.5	-1.1
PC	PSF	62.	32.2	80	116.	10.	174.	-44.	277.	-124.
PT	PSF	119.	40.1	70	187.	77.	233.	55.	277.	44.

RUN 386 VELOCITY 20.0 KT WAVE ENCOUNTERS 40
DRAG 7577. LB FAN DRAG 2180. LB
LCG 13.03 FT AIR FLOW 1242. CFS

		MEAN	RMS	OSC	AVERAGE		1/3 HIGHEST		1/10 HIGHEST	
PITCH	DEG	4.4	2.96	26	8.3	0.8	10.4	-0.5		
HEAVE	FT	3.6	0.39	24	4.0	3.2	4.4	3.0		
BOW ACCEL	G	-0.0	0.65	47	1.1	-0.6	1.7	-1.0	2.2	-1.2
CG ACCEL	G	-0.0	0.36	72	0.5	-0.4	0.9	-0.6	1.2	-0.8
STERN ACCEL	G	-0.0	0.47	74	0.7	-0.5	1.1	-0.9	1.5	-1.1
PC	PSF	59.	24.6	55	102.	24.	142.	-7.	211.	-46.
PT	PSF	120.	47.3	62	195.	72.	248.	48.	293.	33.

TABLE 4-1

PITCH STABILITY RESULTS

RUN	TRIM DEG	VEL KT	HEAVE FT	X* LB	M* FT-LB	PC PSF	PT PSF	EQV DRAG* LB	Q CFS
237	0.9	11.7	1.17	11.9	80.2	35.	97.	14.2	1285.
238	2.0	11.7	1.70	9.3	86.2	54.	98.	12.7	1251.
240	3.0	11.7	1.56	8.7	82.9	63.	93.	12.6	1234.
241	4.0	11.7	1.58	8.2	91.0	70.	92.	12.5	1220.
242	5.1	11.7	1.70	7.6	88.3	73.	93.	12.1	1213.
224	0.5	11.7	2.27	10.9	208.9	69.	155.	15.2	1222.
225	1.2	11.7	2.27	10.2	192.0	68.	155.	14.4	1225.
226	2.1	11.7	2.35	9.9	133.4	69.	155.	14.2	1222.
227	3.0	11.7	2.40	10.1	79.5	77.	155.	14.8	1205.
228	3.9	11.7	2.45	9.9	51.9	78.	155.	14.6	1203.
229	5.1	11.7	2.46	9.4	55.9	81.	153.	14.3	1196.
153	0.0	11.7	2.27	15.9	96.4	64.	224.	19.9	1232.
152	0.5	11.7	2.34	14.9	63.3	67.	226.	19.1	1227.
151	1.0	11.7	2.41	13.7	45.1	66.	225.	17.8	1230.
150	1.9	11.7	2.48	12.5	37.7	73.	227.	17.0	1213.
149	2.9	11.7	2.48	11.7	48.5	80.	226.	16.5	1198.
148	4.0	11.7	2.44	11.0	70.8	86.	225.	16.2	1186.
147	4.4	11.7	2.46	10.6	83.6	88.	227.	15.9	1181.
146	5.0	11.7	2.48	10.1	90.3	80.	226.	14.9	1198.
230	0.5	11.7	2.12	17.5	-27.0	68.	349.	21.7	1225.
232	1.1	11.7	2.16	15.9	-6.7	70.	344.	20.2	1220.
231	1.7	11.7	2.23	14.3	34.4	90.	345.	19.7	1176.
236	2.4	11.7	2.26	13.2	80.2	91.	341.	18.6	1174.
233	3.0	11.7	2.30	12.5	100.4	85.	341.	17.6	1188.
234	4.1	11.7	2.41	10.5	110.5	89.	341.	15.8	1179.
235	5.0	11.7	2.56	8.2	93.7	88.	341.	13.5	1181.

* NOTE: Forces and moments presented in thousands.

TABLE 4-2

PITCH STABILITY RESULTS

	RUN	TRIM DEG	VEL KT	HEAVE FT	X ** LB	M ** FT-LB	PC PSF	PT PSF	EQV DRAG ** LB	Q CFS
	280	3.1	20.0	3.28	5.0	101.7	92.	91.	8.1	1171.
	278	4.0	20.0	3.30	5.1	46.5	99.	92.	8.5	1154.
	279	5.0	20.0	3.18	5.5	10.8	90.	91.	8.6	1176.
*	247	1.0	20.0	2.18	18.4	79.5	20.	155.	19.2	1312.
	249	1.8	20.0	2.78	7.3	343.0	54.	153.	9.3	1251.
	248	1.9	20.0	3.08	6.2	281.7	68.	153.	8.7	1225.
	244	2.4	20.0	3.25	5.4	229.8	75.	156.	8.1	1210.
	245	3.2	20.0	3.34	6.4	149.6	83.	154.	9.4	1193.
	246	4.0	20.0	3.50	5.8	50.5	95.	153.	9.1	1164.
	250	4.9	20.0	3.41	7.1	-20.2	93.	153.	10.4	1169.
*	137	0.9	20.0	2.70	13.6	447.4	0.	224.	13.0	1375.
	131	1.3	20.0	2.85	8.6	495.9	36.	222.	10.0	1285.
	127	1.8	20.1	3.14	7.1	407.0	50.	221.	8.9	1259.
	124	2.5	20.0	3.32	6.8	309.3	64.	223.	9.1	1232.
	123	3.2	20.0	3.41	7.2	167.8	80.	219.	10.0	1200.
	119	3.9	20.0	3.58	6.4	31.0	92.	222.	9.6	1171.
	140	4.0	20.0	3.57	6.5	22.9	92.	221.	9.7	1171.
*	139	4.3	20.0	3.94	11.2	-410.4	197.	218.	15.6	744.
	138	4.3	20.0	3.51	6.8	-5.4	94.	220.	10.0	1166.
	141	4.3	20.0	3.53	6.7	-11.5	90.	222.	9.8	1176.
*	145	4.4	20.0	3.90	10.9	-366.6	153.	218.	15.4	972.
	142	4.5	20.0	3.50	6.9	-27.6	90.	220.	10.0	1176.
	143	4.6	20.0	3.49	7.2	-39.1	89.	219.	10.3	1179.
	144	4.7	20.0	3.51	7.4	-55.9	87.	219.	10.5	1183.
	201	2.1	20.0	3.02	11.7	558.6	34.	351.	13.0	1288.
	265	2.4	20.0	3.21	11.1	435.3	55.	341.	13.1	1251.
	262	3.1	20.0	3.60	7.1	111.9	93.	342.	10.3	1169.
**	263	3.7	20.0	4.00	10.7	-368.6	125.	340.	14.7	1076.
	264	3.8	20.0	3.71	7.7	0.7	90.	338.	10.8	1176.

** NOTE: Forces and moments presented in thousands.

*Unsteady running condition.

**Bi-stable heave condition.

TABLE 4-3

PITCH STABILITY RESULTS

	RUN	TRIM DEG	VEL KT	HEAVE FT	X* LB	M* FT-LB	PC PSF	PT PSF	EQV DRAG* LB	Q CFS
	271	2.0	30.0	3.58	4.6	29.0	93.	86.	6.7	1169.
	272	2.4	30.0	3.51	4.9	19.5	93.	84.	7.1	1169.
	274	2.9	30.0	3.46	4.1	3.4	89.	89.	6.2	1176.
	275	3.4	30.0	3.36	4.1	-2.0	90.	89.	6.2	1176.
	276	4.1	30.0	3.25	5.9	-39.8	82.	90.	7.8	1193.
**	261	0.0	30.0	3.23	13.3	94.3	57.	143.	14.7	1247.
	260	0.7	30.0	3.85	6.6	144.2	97.	147.	8.8	1159.
	259	1.1	30.0	3.91	5.5	105.8	97.	150.	7.7	1159.
	258	1.6	30.0	3.84	4.6	70.8	103.	151.	6.9	1145.
	251	2.0	30.0	3.89	5.1	16.2	99.	151.	7.3	1154.
	252	2.4	30.0	3.80	6.2	-4.7	100.	151.	8.5	1152.
	253	2.8	30.0	3.71	7.1	-51.2	93.	150.	9.2	1169.
	255	3.2	30.0	3.63	7.8	-84.2	86.	150.	9.8	1186.
	256	3.5	30.0	3.58	11.0	-171.8	75.	151.	12.8	1210.
	257	3.5	30.0	3.70	13.1	-441.3	23.	151.	13.7	1305.
**	136	-0.5	30.0	3.52	9.1	320.7	68.	221.	10.7	1225.
	135	-0.1	30.0	3.76	6.6	318.7	73.	220.	8.3	1215.
	134	0.2	30.0	3.81	7.0	281.7	80.	220.	8.9	1200.
	130	0.4	30.0	3.84	7.3	240.6	106.	222.	9.7	1132.
	133	0.8	30.0	3.91	7.3	163.1	97.	219.	9.5	1159.
	128	1.2	30.0	3.98	6.3	78.8	103.	220.	8.6	1142.
	125	2.1	30.0	3.94	5.9	29.0	102.	218.	8.2	1145.
	121	2.8	30.0	3.79	7.8	-73.4	89.	218.	9.9	1179.
	126	3.1	30.0	3.80	10.8	-446.7	26.	218.	11.4	1302.
	270	0.8	30.0	3.99	8.5	179.2	88.	336.	10.5	1181.
	269	1.2	30.0	3.97	5.9	88.3	100.	336.	8.1	1152.
	266	2.0	30.0	3.99	7.1	11.5	102.	337.	9.4	1147.
	267	2.3	30.0	3.92	7.9	-32.3	99.	336.	10.1	1154.
	268	2.7	30.0	3.85	8.8	-122.6	84.	336.	10.7	1191.

* NOTE: Forces and moments presented in thousands.

** Bi-stable heave condition.

TABLE 5-1

YAW STABILITY RESULTS

RUN	YAW DEG	TRIM DEG	VEL KT	HEAVE FT	X* LB	Y* LB	N* FT-LB	K* FT-LB	M* FT-LB	PC PSF	PT PSF	EQV DRAG* LB	Q CFS
205	0.	0.5	11.7	1.15	11.9	0.3	-4.0	3.4	76.8	25.	96.	13.5	1305.
206	5.	0.5	11.7	1.13	12.5	0.9	2.1	3.4	62.7	31.	94.	14.5	1293.
218	0.	0.5	11.7	2.00	8.6	0.3	-3.9	10.1	222.4	70.	131.	13.0	1220.
217	0.	0.5	11.7	2.13	10.9	0.1	-2.6	9.5	209.6	71.	155.	15.3	1217.
216	10.	0.5	11.7	2.05	11.1	3.3	4.2	14.1	208.9	70.	155.	15.8	1220.
215	15.	0.5	11.7	1.92	11.0	4.6	13.7	21.4	212.9	66.	155.	15.9	1230.
214	20.	0.5	11.7	1.74	11.5	6.7	21.1	27.4	212.3	69.	155.	17.3	1222.
213	25.	0.5	11.7	1.57	12.6	8.8	28.5	28.1	201.5	64.	155.	19.1	1232.
212	30.	0.6	11.7	1.41	12.3	11.8	41.4	27.2	194.7	65.	155.	20.6	1230.
194	0.	0.5	11.7	2.32	14.7	0.1	-1.3	9.4	60.0	66.	228.	18.8	1227.
195	5.	0.5	11.7	2.32	14.5	2.1	-2.7	1.4	61.3	67.	228.	18.8	1227.
196	10.	0.6	11.7	2.22	14.8	4.1	2.0	-1.4	90.3	69.	226.	19.5	1222.
197	15.	0.5	11.7	2.02	15.9	6.1	16.2	5.2	155.0	74.	226.	21.5	1213.
198	20.	0.6	11.7	1.83	17.1	8.2	33.8	14.5	177.2	71.	227.	23.2	1220.
199	25.	0.4	11.7	1.67	17.2	10.9	54.1	21.8	199.4	68.	226.	24.4	1222.
200	30.	0.4	11.7	1.12	22.0	17.4	78.1	-4.5	152.3	41.	228.	30.4	1276.
187	0.	5.0	11.7	2.50	9.6	0.2	-1.5	5.5	96.4	89.	230.	14.9	1179.
188	5.	5.0	11.7	2.45	10.0	1.7	-4.7	15.3	84.2	89.	228.	15.4	1179.
189	10.	5.0	11.7	2.35	10.8	2.8	-3.9	24.7	68.7	88.	225.	16.4	1181.
190	15.	5.0	11.7	2.27	11.3	4.9	-5.7	35.7	51.9	86.	223.	17.3	1186.
191	20.	5.0	11.7	2.21	11.3	6.4	-4.7	47.1	44.5	85.	223.	17.9	1188.
192	25.	5.0	11.7	2.12	11.3	7.9	1.5	48.6	29.0	84.	222.	18.6	1191.
193	30.	5.0	11.7	2.06	11.3	10.0	7.6	41.3	5.4	77.	222.	19.5	1205.
219	0.	0.5	11.7	2.27	15.5	0.1	0.1	12.1	22.9	73.	259.	20.0	1213.
220	10.	0.6	11.7	2.20	15.8	4.4	2.0	0.7	49.9	78.	257.	21.0	1203.
221	15.	0.6	11.7	1.94	17.3	6.8	17.6	4.5	115.2	77.	257.	23.1	1205.
222	20.	0.6	11.7	1.67	19.2	9.4	39.2	11.0	155.7	64.	259.	25.3	1232.
223	25.	0.4	11.7	1.36	25.6	13.9	74.8	-5.2	131.4	45.	265.	32.0	1268.
202	0.	0.1	11.7	1.99	19.5	0.2	0.7	14.1	-55.9	63.	357.	23.4	1234.
203	0.	0.6	11.7	2.09	17.7	0.2	0.8	11.4	-31.0	94.	353.	23.2	1166.
204	5.	0.6	11.7	2.09	16.6	2.5	2.8	8.1	-18.2	76.	353.	21.4	1208.

* NOTE: Forces and moments presented in thousands.

TABLE 5-2

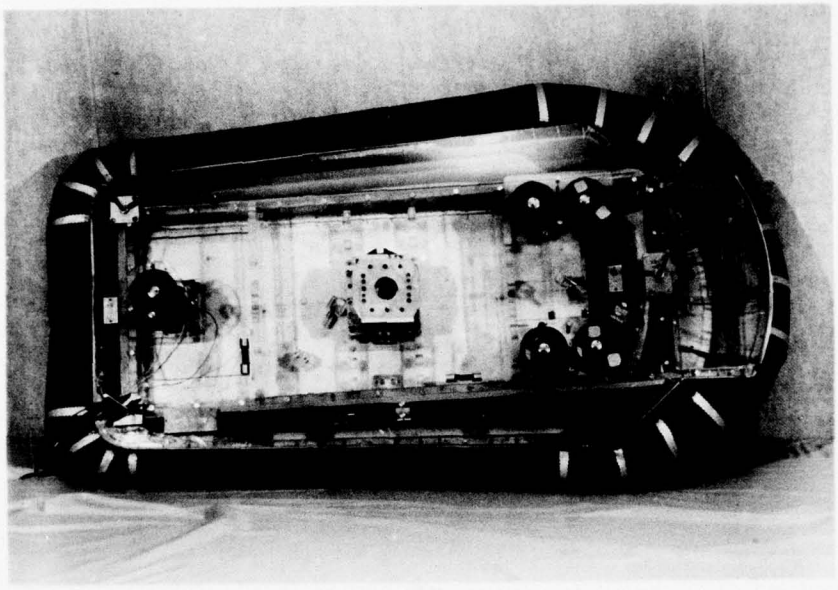
YAW STABILITY RESULTS

RUN	YAW DEG	TRIM DEG	VEL KT	HEAVE FT	X* LB	Y* LB	N* FT-LB	K* FT-LB	M* FT-LB	PC PSF	PT PSF	EQV DRAG* LB	Q CFS
163	0.	1.9	20.0	3.16	7.0	0.4	-0.5	6.8	386.8	54.	220.	9.0	1251.
164	2.	1.9	20.0	3.15	7.0	0.8	3.1	11.4	382.7	56.	220.	9.1	1249.
165	5.	1.9	20.0	3.18	7.1	1.6	5.4	21.4	374.0	59.	220.	9.4	1242.
166	10.	1.8	20.0	3.37	6.3	3.1	8.1	42.2	334.2	63.	221.	9.0	1234.
167	15.	1.8	20.0	3.44	6.1	5.2	8.6	59.1	290.4	70.	221.	9.8	1220.
168	20.	1.8	20.0	3.55	5.9	7.6	19.0	68.2	283.0	75.	220.	10.8	1210.
169	25.	1.8	20.0	3.63	5.6	8.8	18.9	66.8	239.9	78.	220.	11.6	1203.
154	0.	3.9	20.0	3.57	6.3	0.6	0.4	6.1	35.0	94.	220.	9.6	1166.
155	2.	3.9	20.0	3.55	6.3	1.1	4.4	14.6	35.7	94.	219.	9.6	1166.
156	5.	3.9	20.0	3.61	6.4	2.2	3.2	27.5	45.8	96.	220.	9.9	1159.
157	10.	3.9	20.0	3.69	6.8	3.9	-2.8	48.1	48.5	102.	219.	10.9	1147.
158	15.	3.9	20.0	3.71	7.3	5.5	-5.9	52.4	20.2	100.	219.	11.9	1152.
160	20.	3.8	20.0	3.80	8.1	7.7	-8.6	33.7	-39.1	90.	218.	13.4	1176.
** 161	25.	3.7	20.0	3.83	7.0	11.9	-36.8	15.2	-70.1	88.	218.	14.4	1181.
162	30.	3.6	20.0	3.87	6.2	14.9	-52.1	-12.9	-139.5	82.	217.	15.7	1193.
179	0.	0.5	30.0	3.85	7.4	1.6	15.6	12.0	219.0	87.	222.	9.5	1183.
180	5.	0.5	30.0	3.90	7.0	3.5	12.3	23.5	192.7	89.	221.	9.3	1179.
181	10.	0.4	30.0	4.05	5.9	3.9	10.3	24.9	153.0	91.	221.	8.6	1174.
182	15.	0.4	30.0	4.10	5.8	4.0	12.3	22.2	139.5	92.	221.	8.7	1171.
184	20.	0.4	30.0	4.15	5.1	5.8	2.8	11.4	135.4	89.	223.	8.8	1179.
185	25.	0.4	30.0	4.17	4.1	7.0	-4.6	14.9	80.9	92.	226.	8.8	1171.
186	30.	0.4	30.0	4.22	3.2	6.5	-7.9	25.7	38.4	88.	230.	8.1	1181.
170	0.	2.5	30.0	3.84	7.1	1.5	-4.9	-5.2	-14.2	100.	217.	9.4	1149.
172	5.	2.4	30.0	3.88	7.4	4.6	-12.7	3.2	-51.2	95.	218.	9.9	1164.
173	10.	2.3	30.0	3.86	7.9	5.7	-10.2	-3.0	-91.0	83.	218.	10.7	1193.
174	10.	2.4	30.0	3.83	8.2	5.7	-7.0	-6.5	-108.5	84.	223.	11.0	1191.
175	15.	2.4	30.0	3.88	7.4	8.6	-26.2	-13.8	-126.0	79.	221.	11.3	1203.
176	20.	2.5	30.0	3.83	6.6	10.0	-33.1	-16.1	-134.1	78.	219.	11.4	1203.
177	25.	2.5	30.0	3.85	5.3	11.1	-40.5	-16.5	-146.9	75.	220.	11.3	1210.
178	30.	2.4	30.0	3.88	5.1	11.2	-41.3	-19.8	-176.5	69.	221.	11.7	1222.

* NOTE: Forces and moments presented in thousands.

** Bi-stable heave condition.

FIGURE 1. 1/9 SCALE FSHACV MODEL



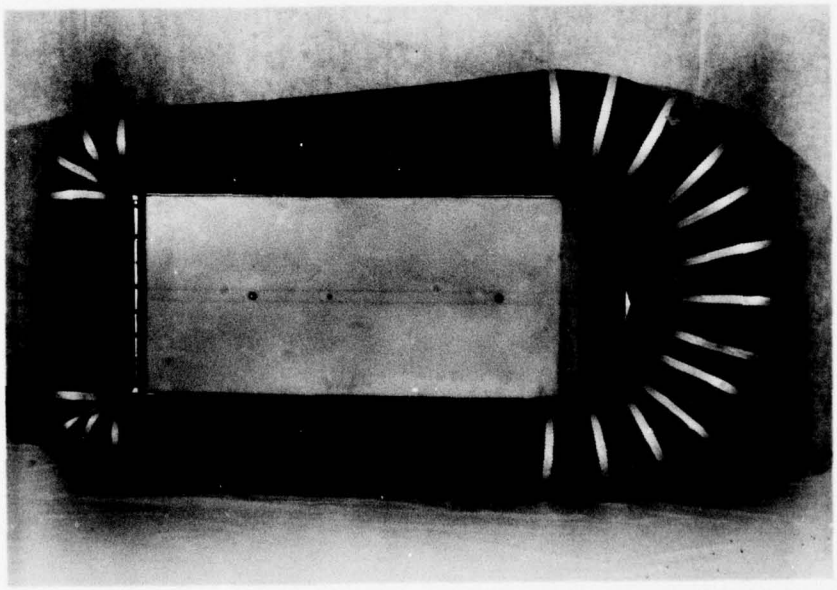


FIGURE 2. TOP AND BOTTOM VIEWS OF MODEL

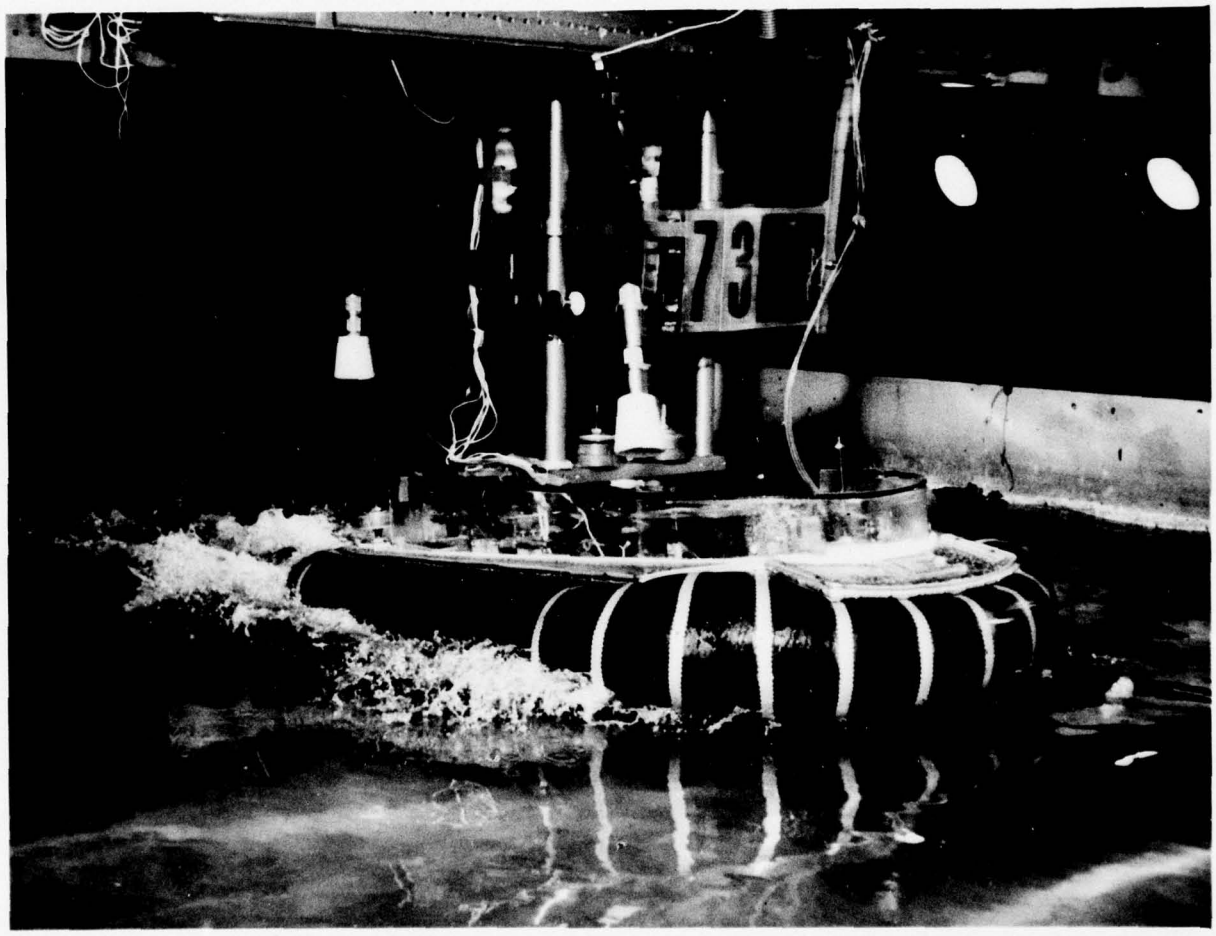


FIGURE 3. MODEL SET-UP

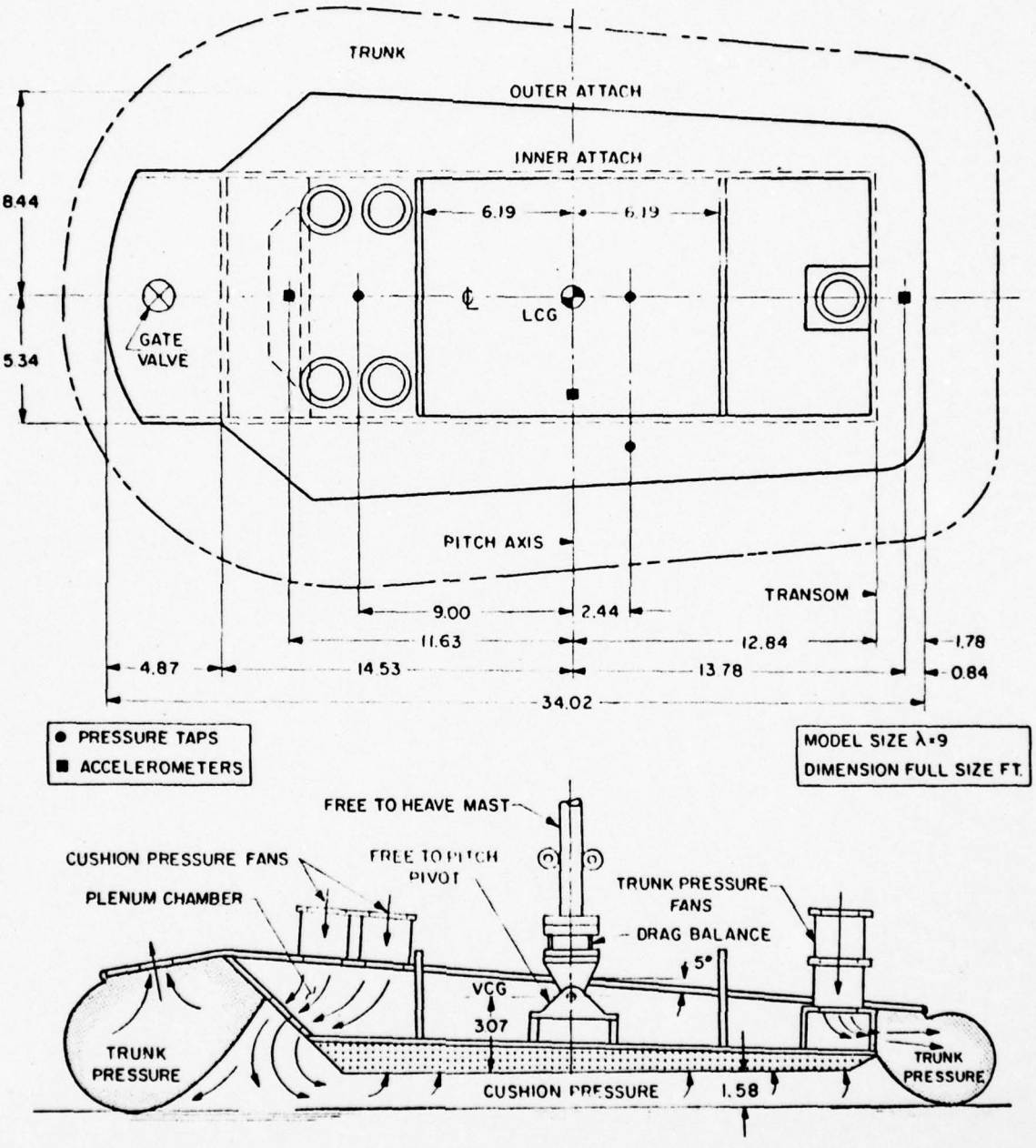


FIG. 4. SCHEMATIC OF MODEL AND PRINCIPLE FSACV DIMENSIONS

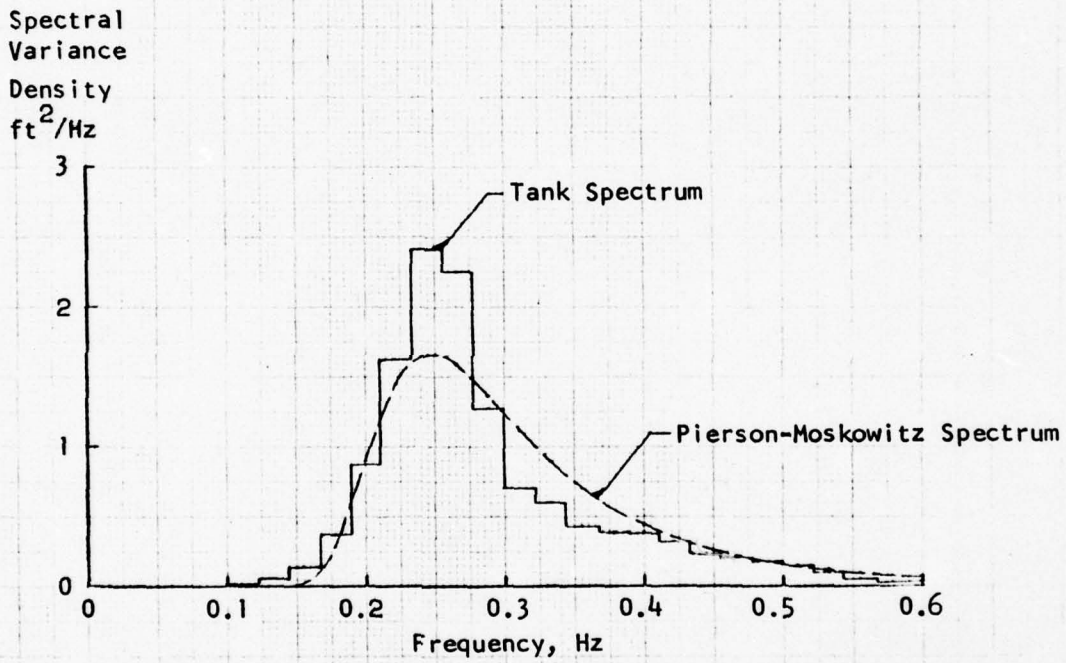


FIGURE 5 SEA STATE 2 WAVE SPECTRA
$H_{1/3}$ = 2.2 FT

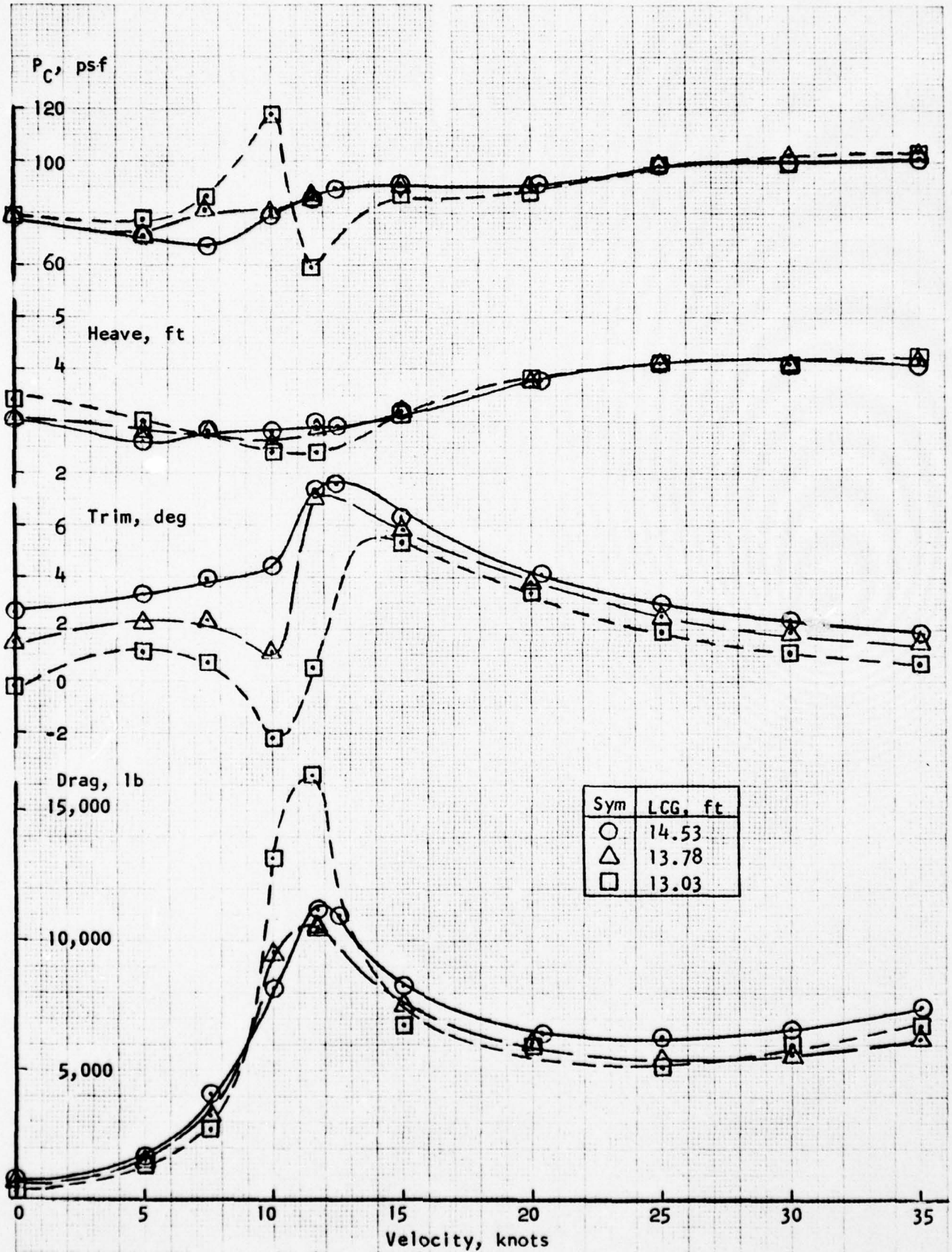


FIGURE 6A FREE-TO-TRIM PERFORMANCE IN CALM WATER
NOMINAL TRUNK PRESSURE = 220 PSF, Q = 1180 CFS

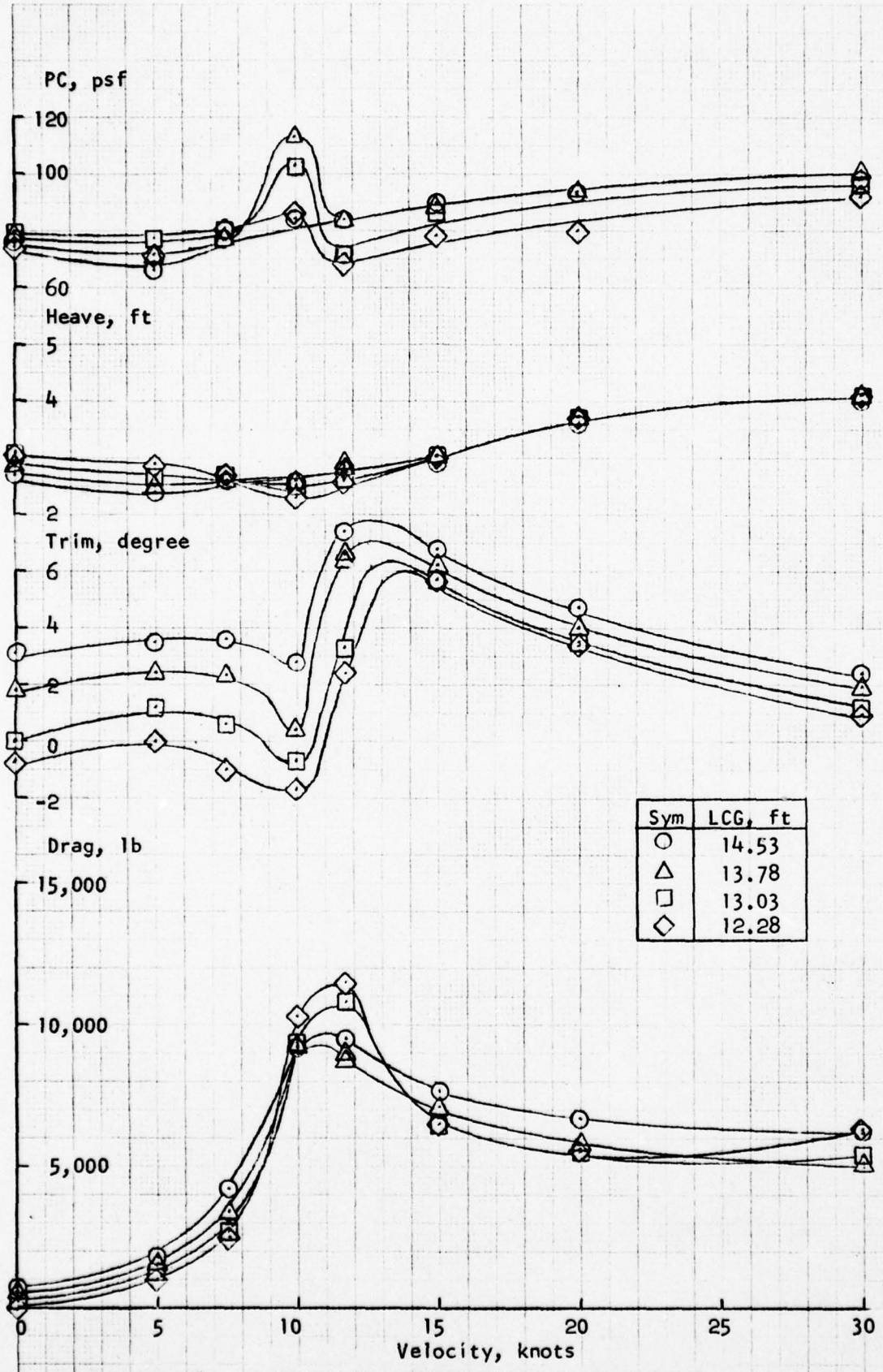


FIGURE 6B FREE-TO-TRIM PERFORMANCE IN CALM WATER
NOMINAL TRUNK PRESSURE = 150 PSF, Q = 1180 CFS

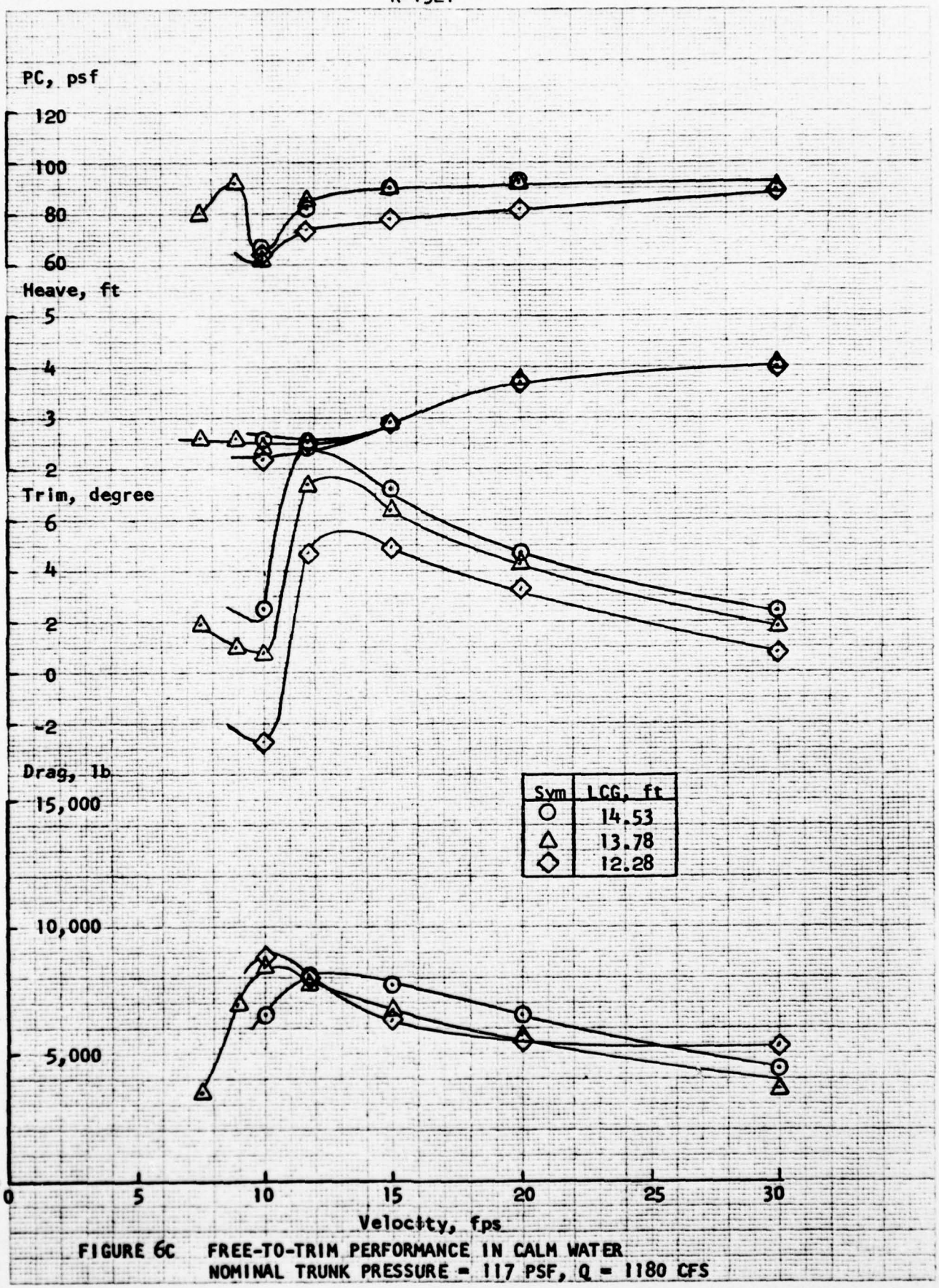


FIGURE 6C FREE-TO-TRIM PERFORMANCE IN CALM WATER
NOMINAL TRUNK PRESSURE = 117 PSF, Q = 1180 CFS

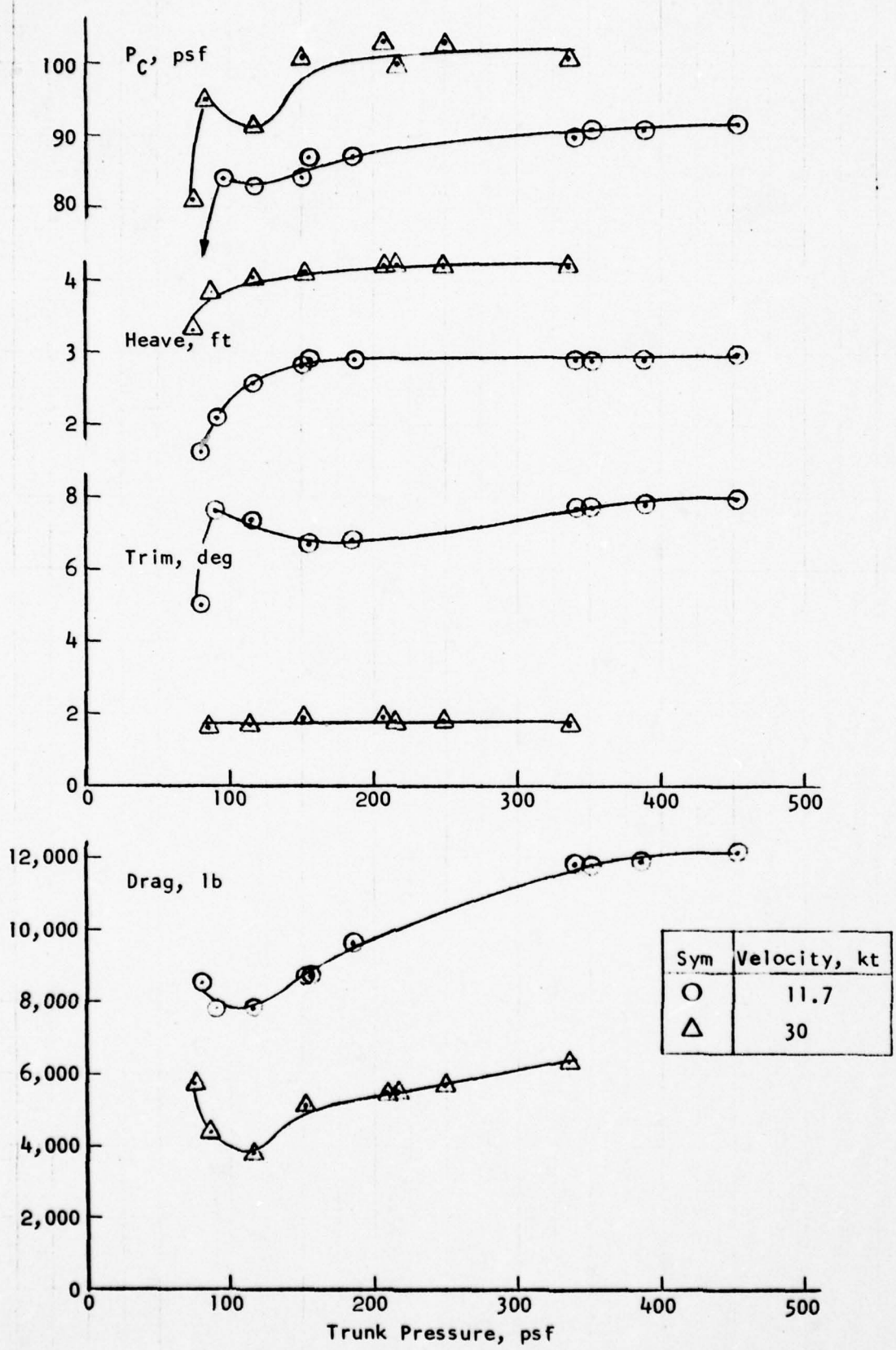


FIGURE 7 FREE-TO-TRIM PERFORMANCE IN CALM WATER
LCG = 13.78 FT, Q = 1180 CFS

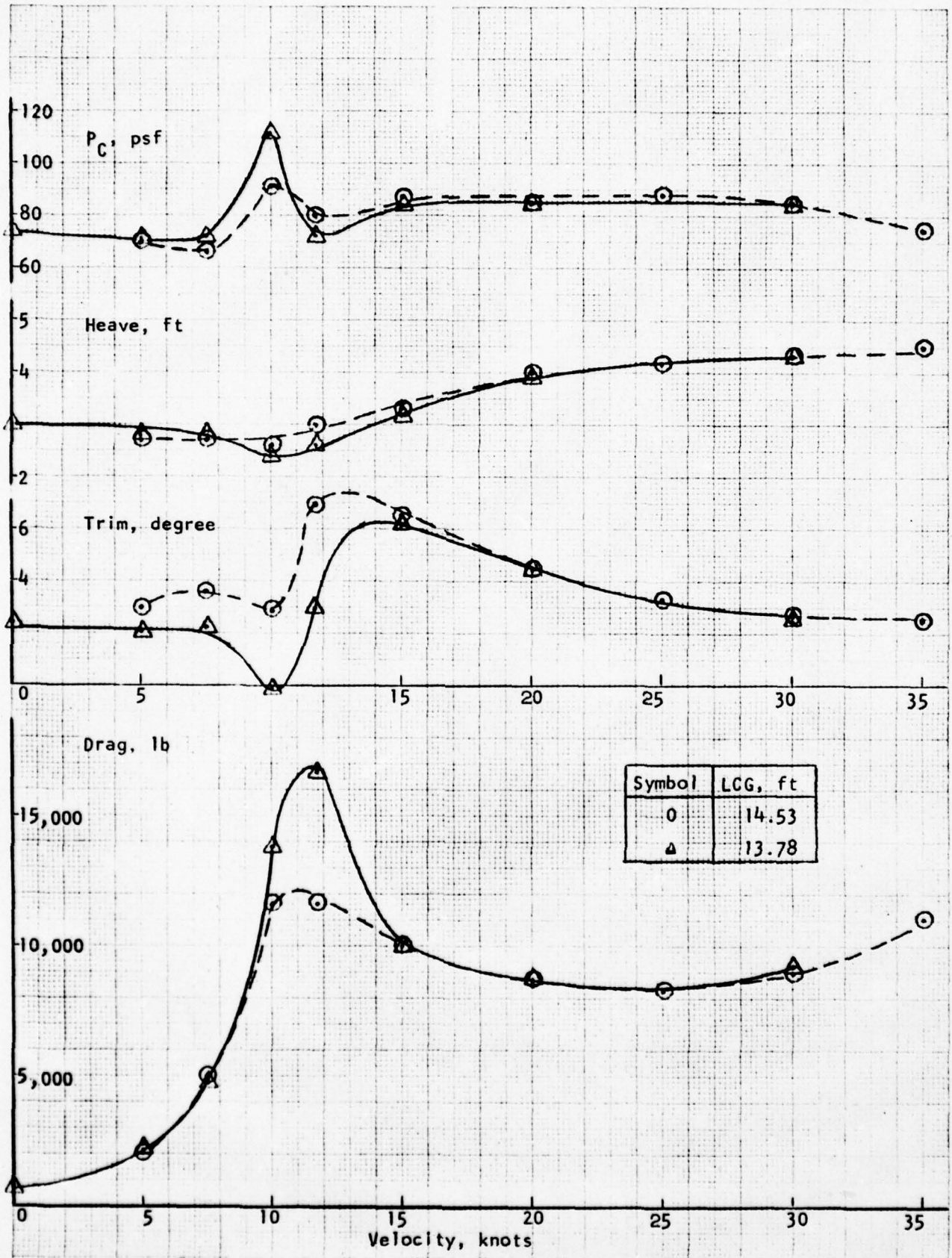


FIGURE 8A PERFORMANCE IN SEA STATE 2
NOMINAL TRUNK PRESSURE = 220 PSF, Q = 1200 CFS

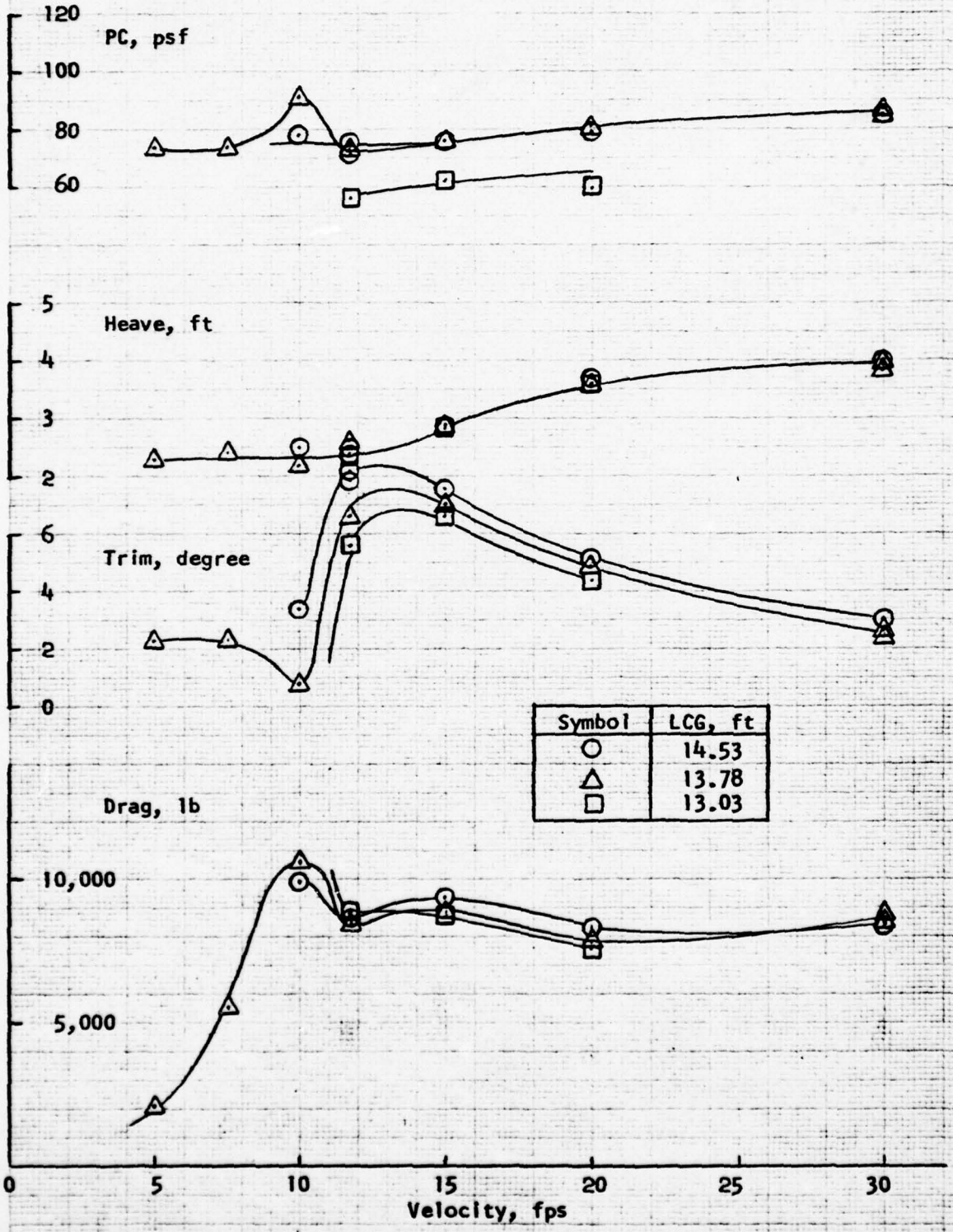


FIGURE 88 PERFORMANCE IN SEA STATE 2
NOMINAL TRUNK PRESSURE = 120 PSF, Q = 1200 CFS

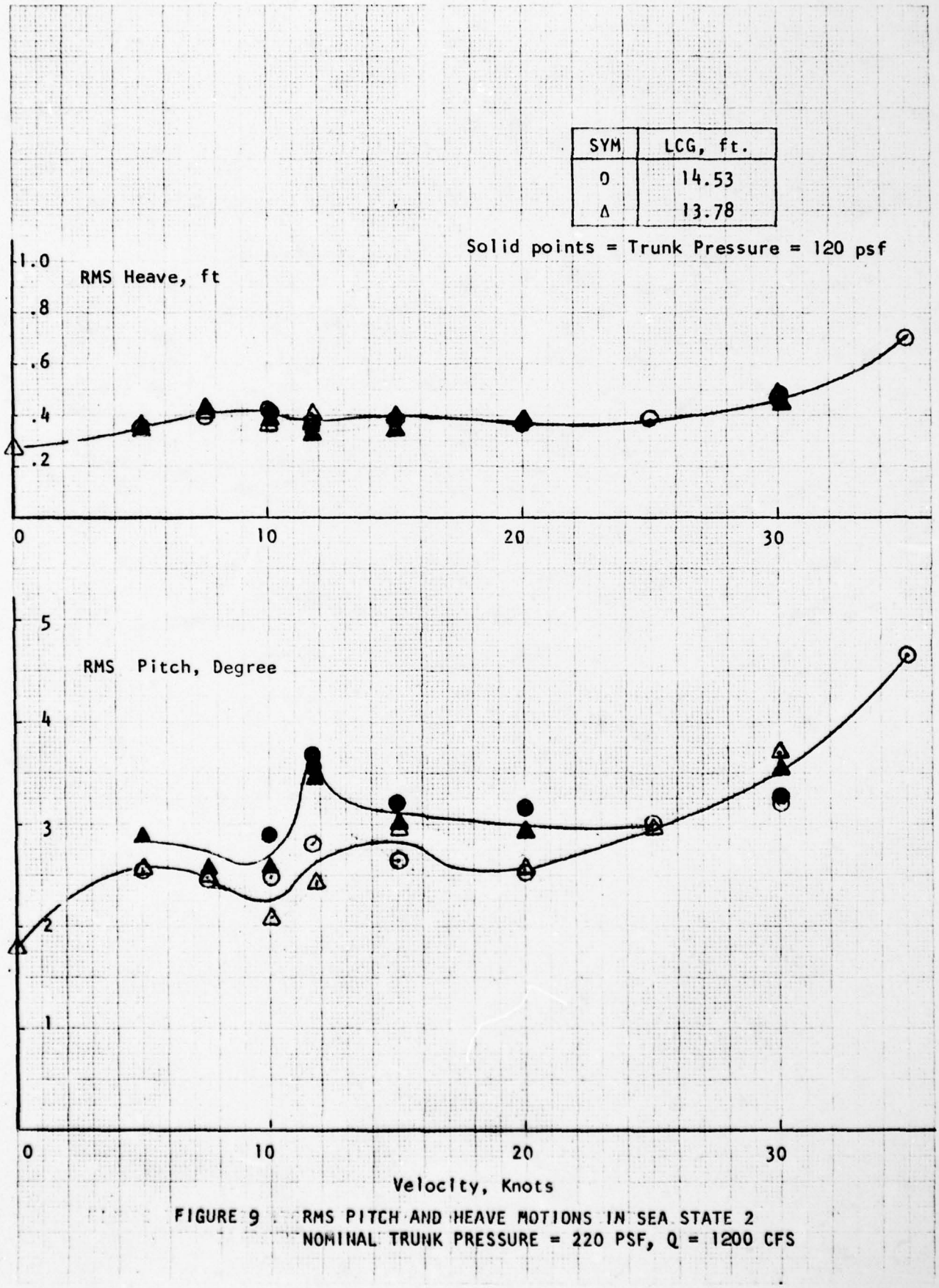


FIGURE 9 RMS PITCH AND HEAVE MOTIONS IN SEA STATE 2
NOMINAL TRUNK PRESSURE = 220 PSF, Q = 1200 CFS

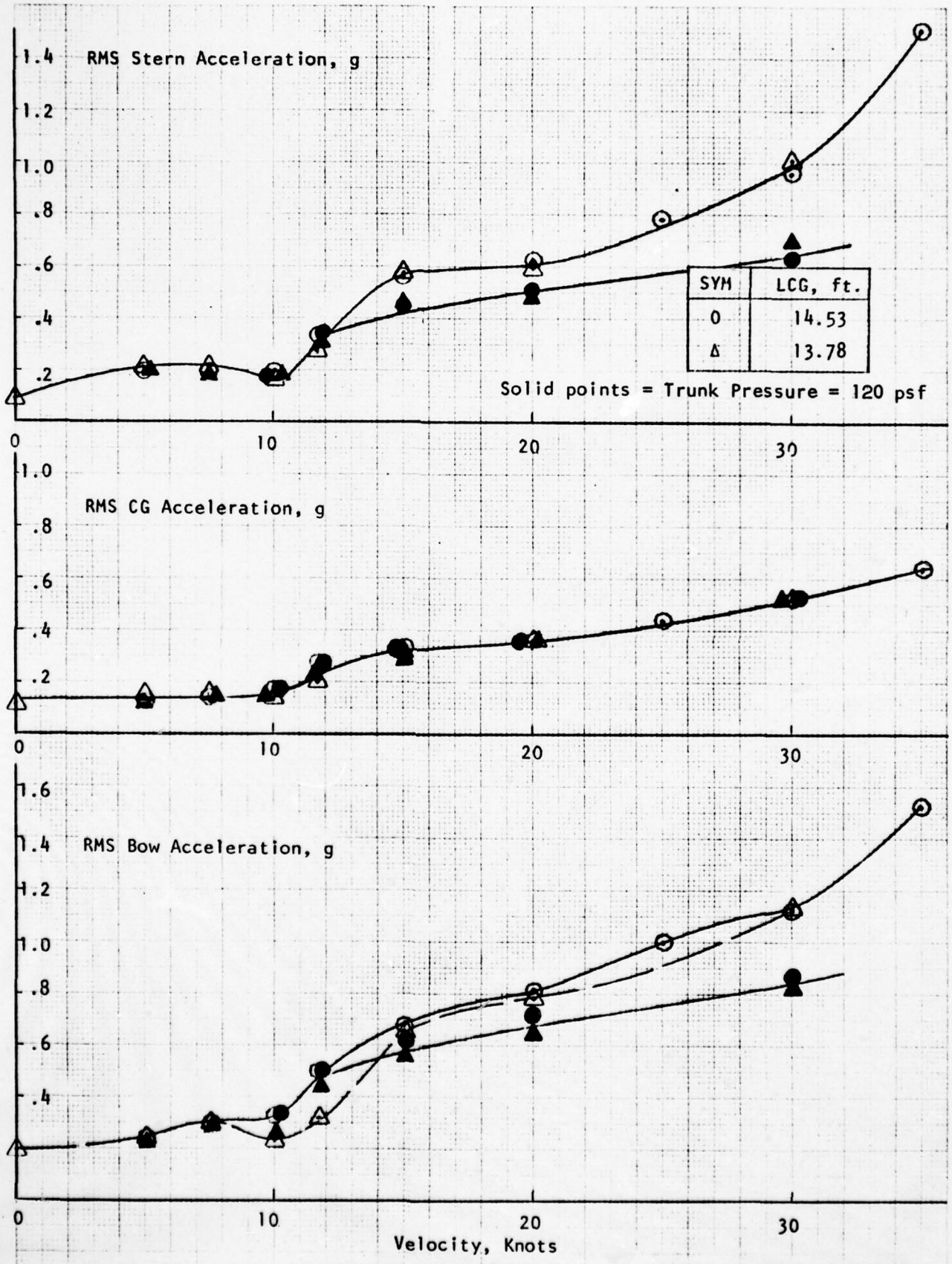


FIGURE 10 RMS ACCELERATIONS IN SEA STATE 2. NOMINAL TRUNK PRESSURE = 220 PSF
Q = 1200 CFS

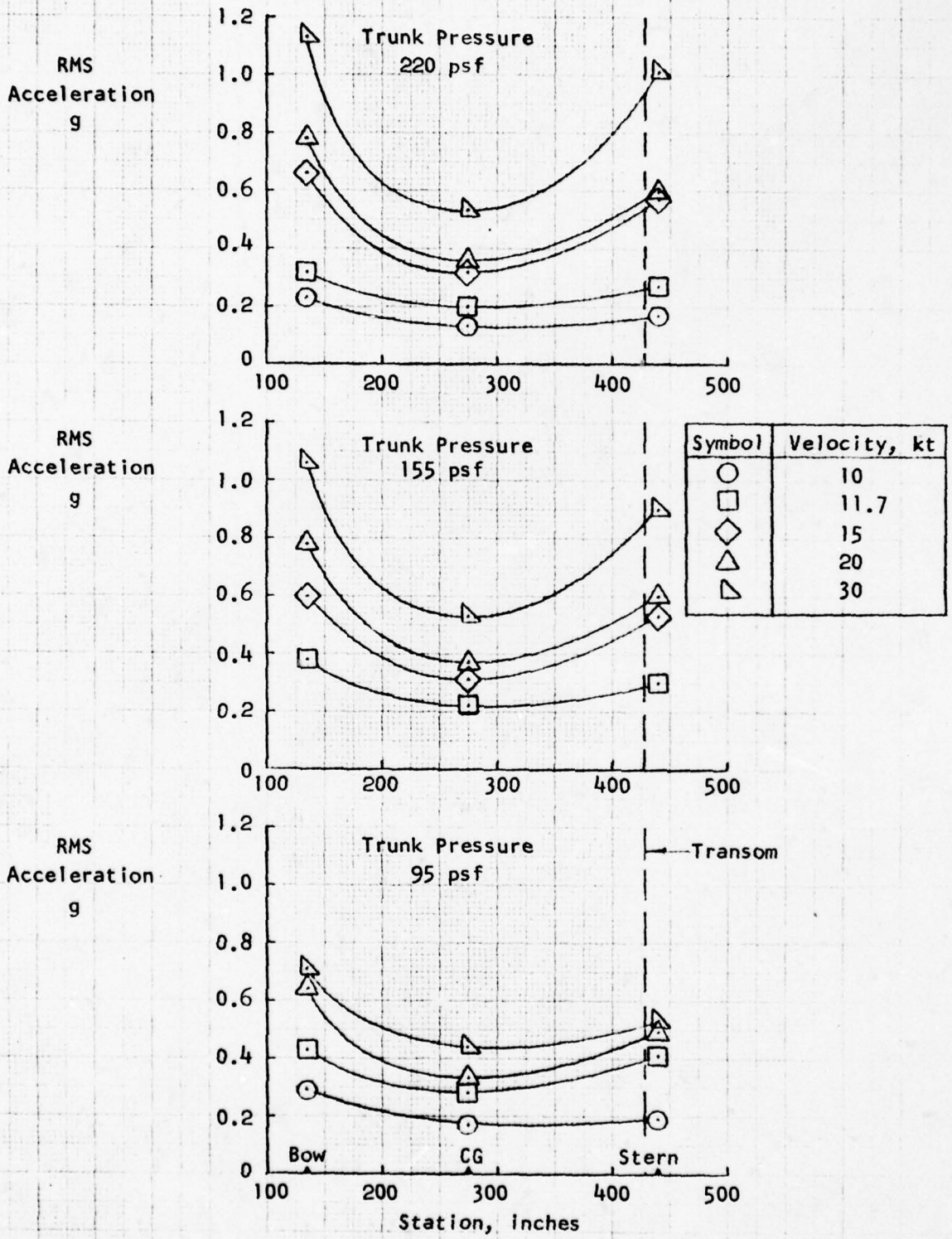


FIGURE 11 RMS ACCELERATIONS IN SEA STATE 2
LCG = 13.78 FT, Q = 1200 CFS

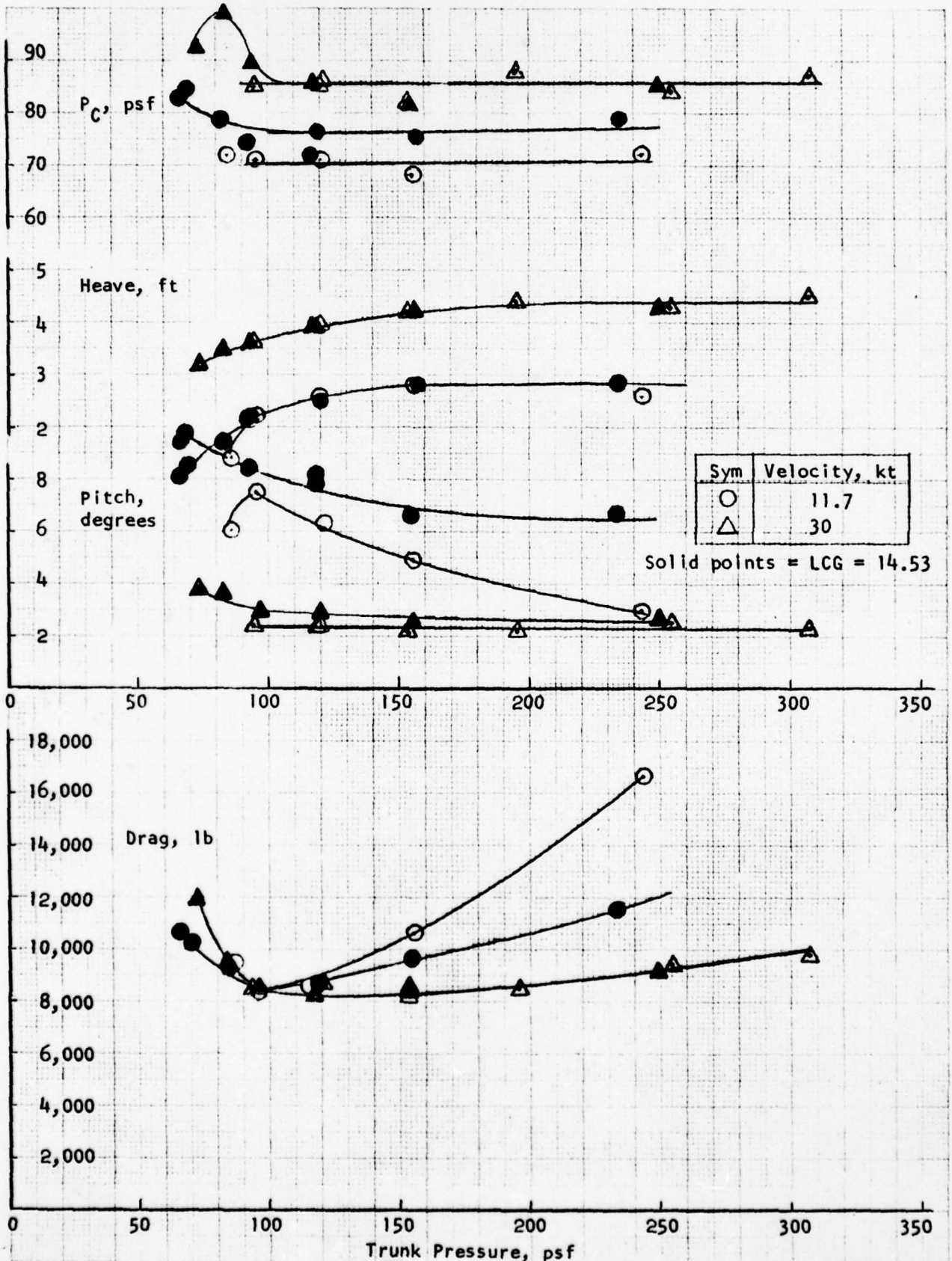


FIGURE 12 PERFORMANCE IN SEA STATE 2
LCG = 13.78 FT, Q = 1200 CFS

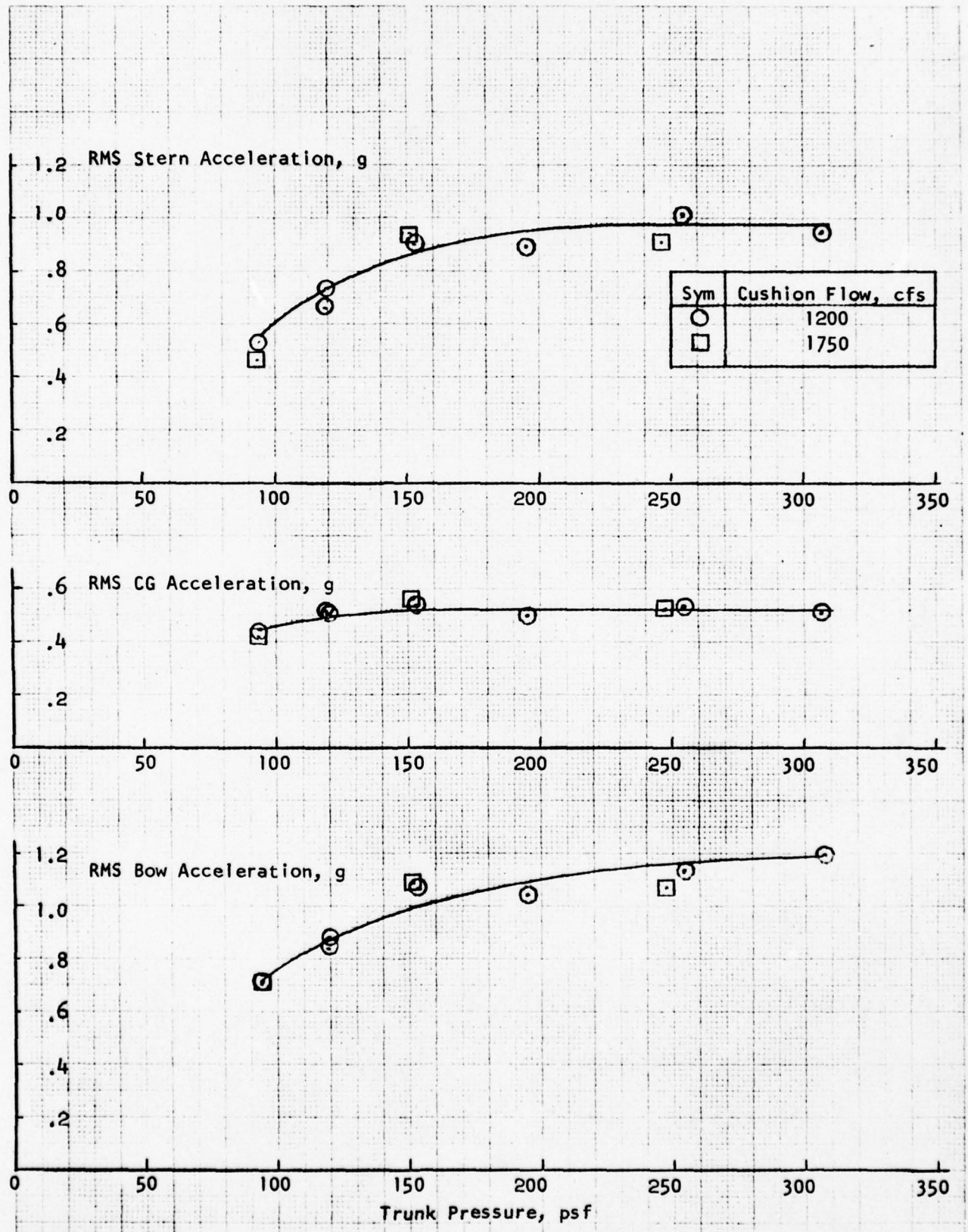


FIGURE 13 RMS ACCELERATIONS IN SEA STATE 2 AT 30 KNOTS
LCG = 13.78 FT

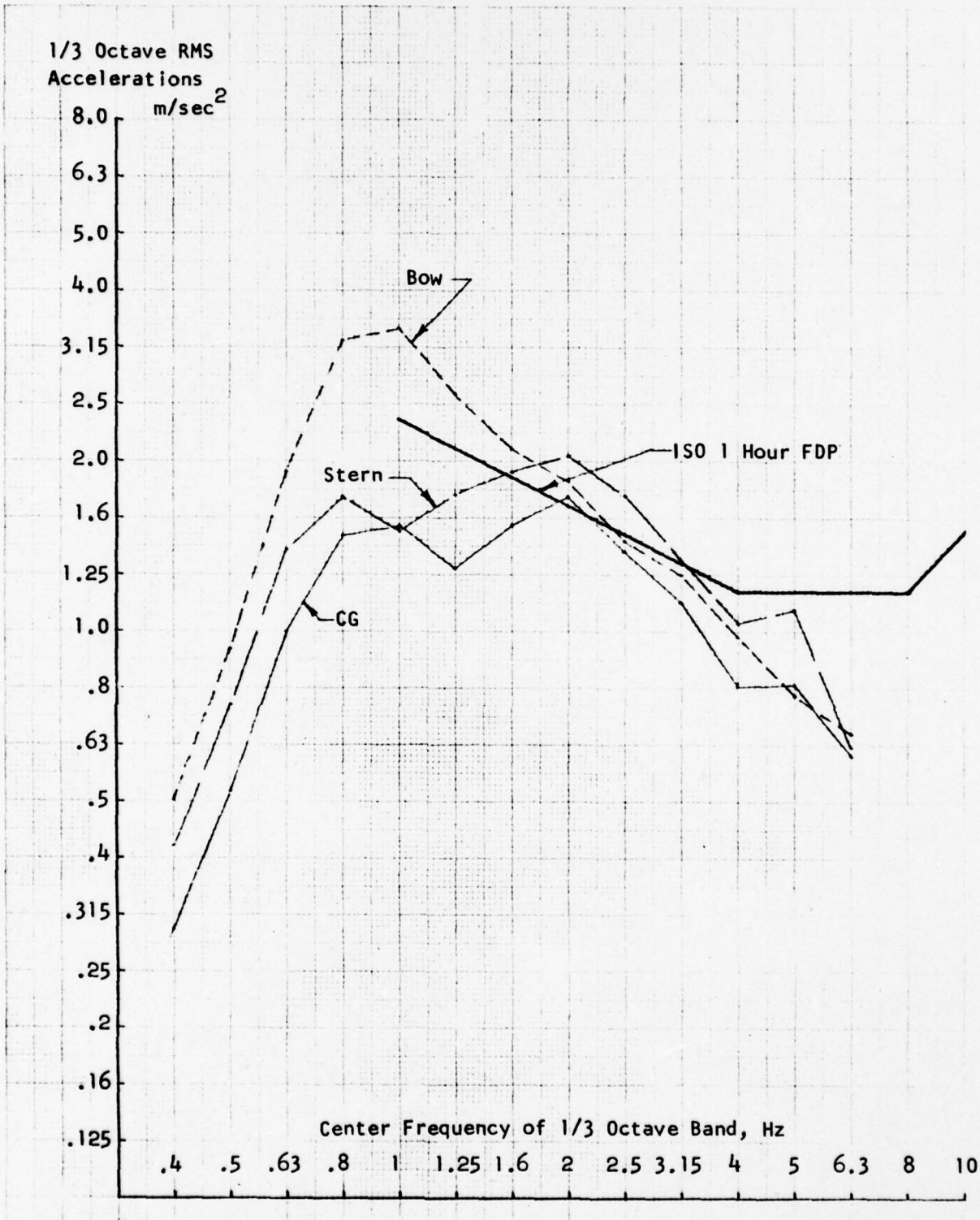


FIGURE 14 HABITABILITY IN SEA STATE 2 at 56,000 LB
LCG = 13.78 FT AFT OF STATION 100
SPEED = 30 KT
TRUNK PRESSURE = 95 PSF

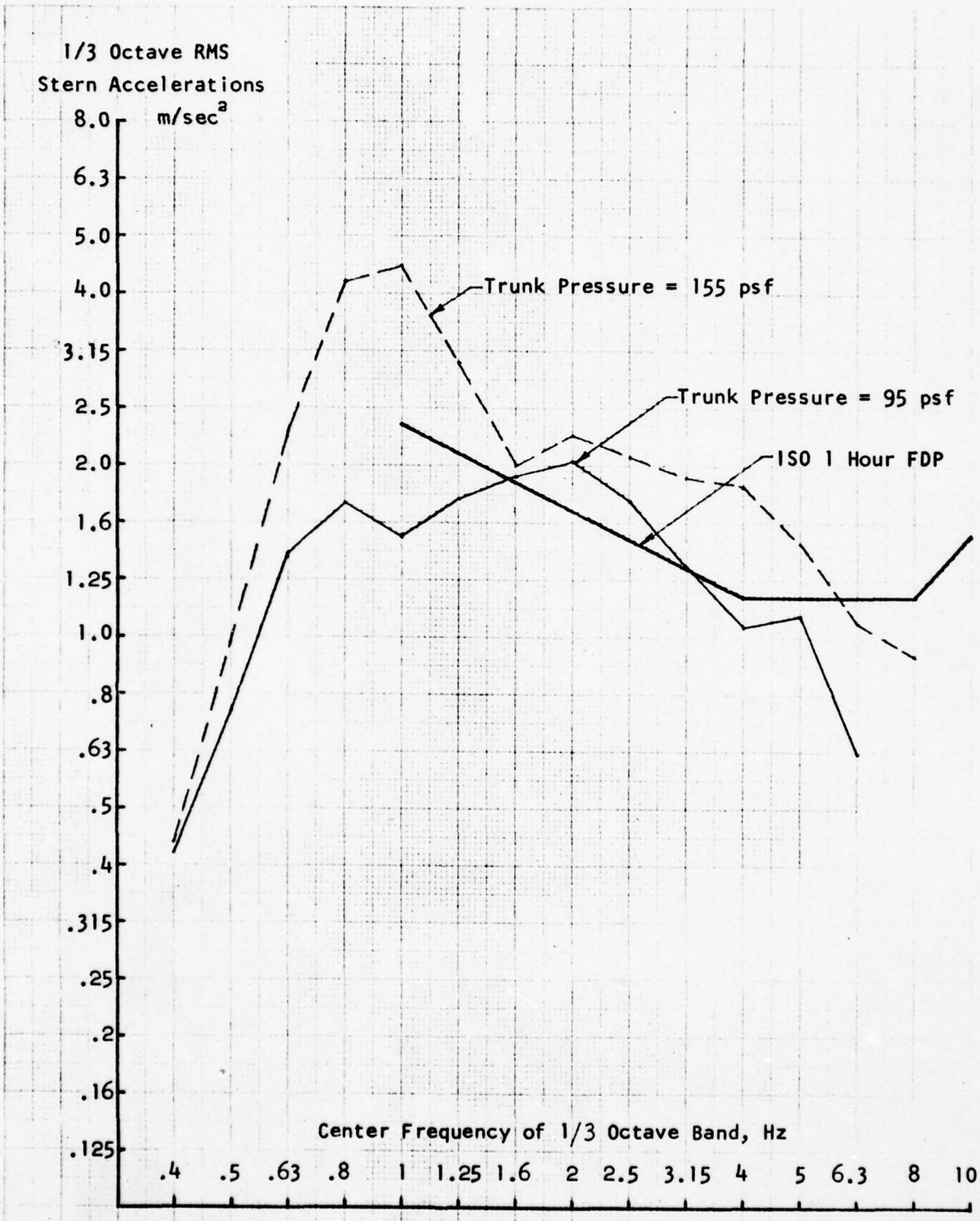


FIGURE 15 HABITABILITY IN SEA STATE 2 AT 56,000 LB
LCG = 13.78 FT AFT OF STATION 100
SPEED = 30 KNOTS

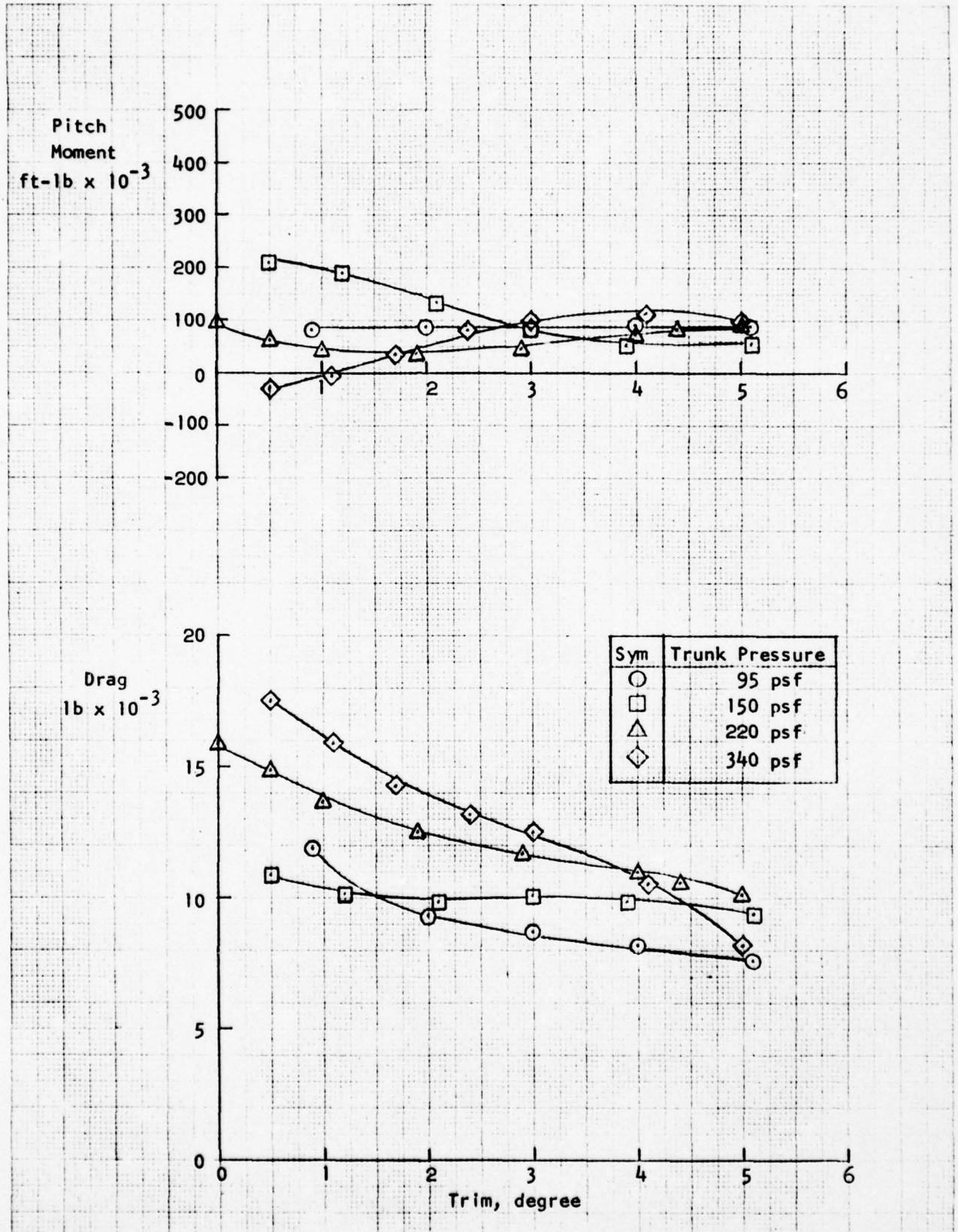


FIGURE 16 PITCH STABILITY AT 11.7 KNOTS

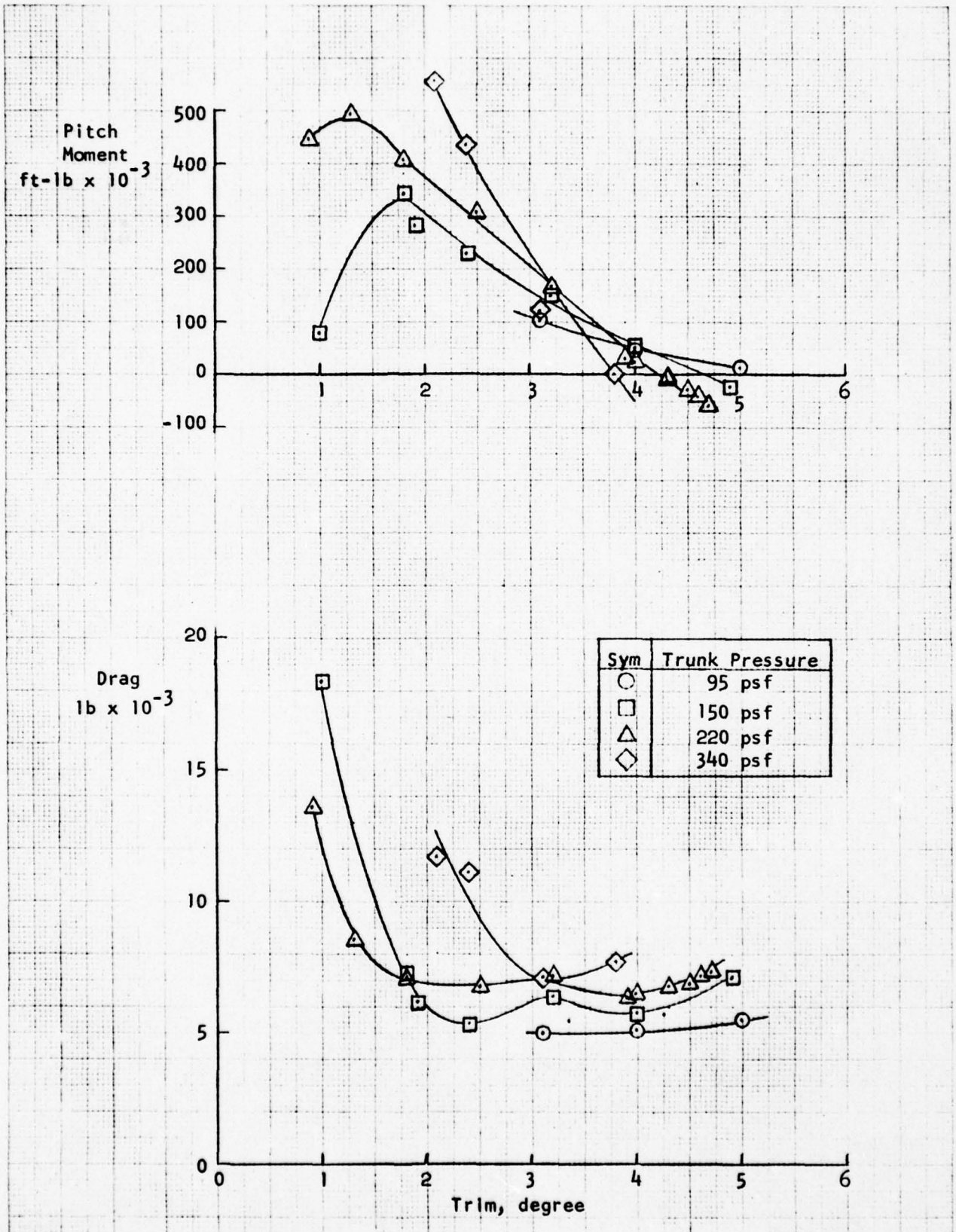


FIGURE 17 PITCH STABILITY AT 20 KNOTS

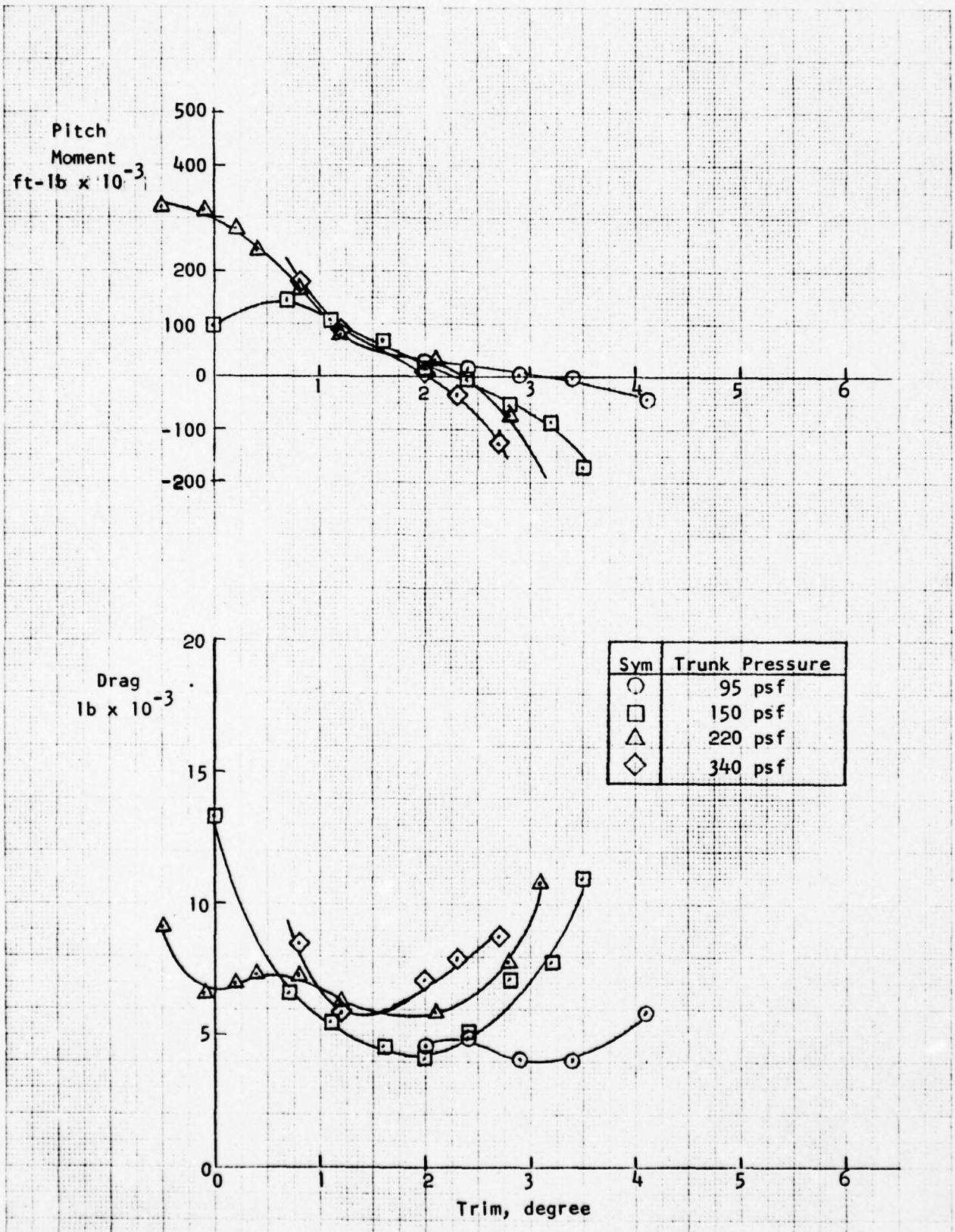


FIGURE 18 PITCH STABILITY AT 30 KNOTS

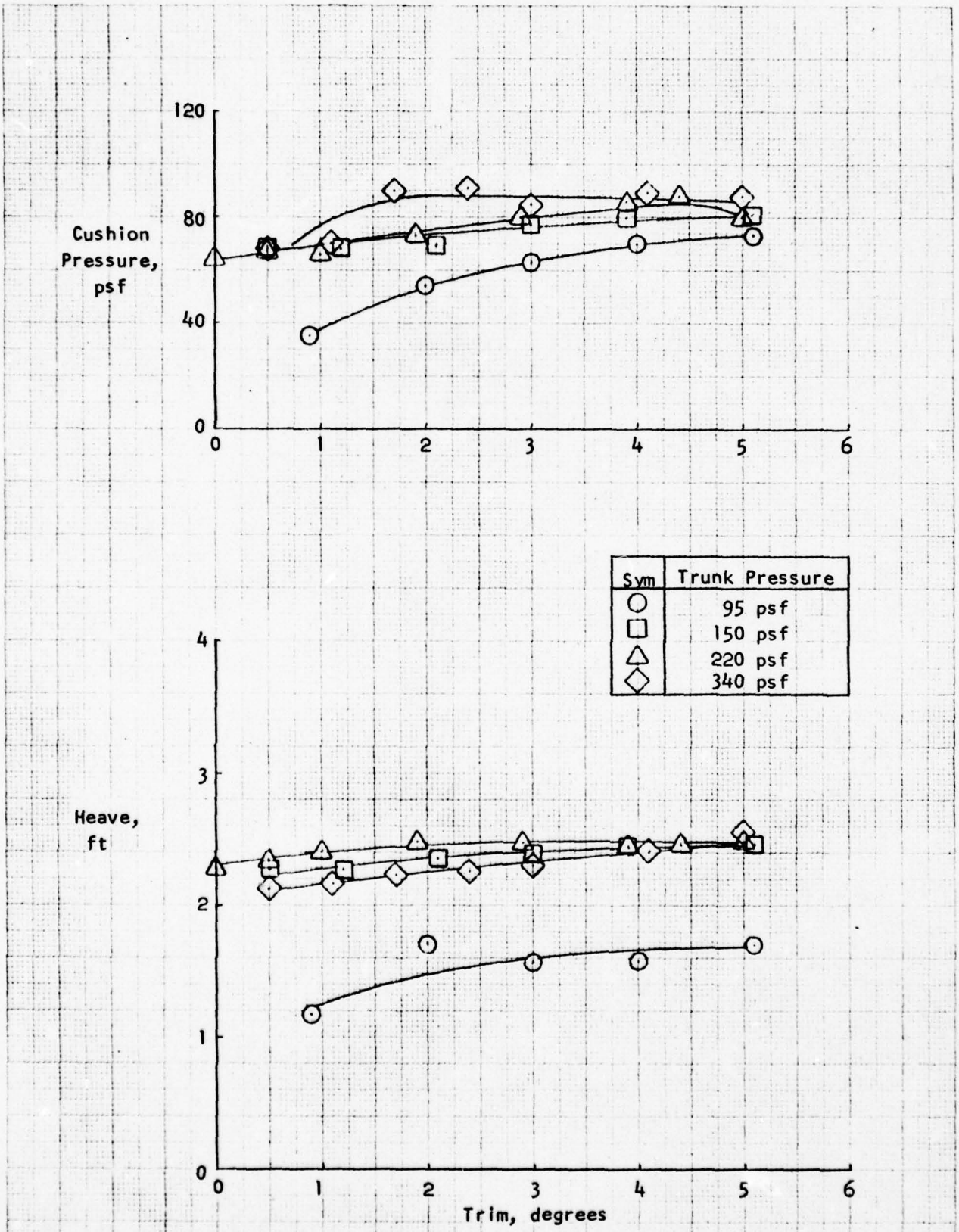


FIGURE 19 FIXED TRIM RESULTS AT 11.7 KNOTS
CUSHION PRESSURE AND HEAVE

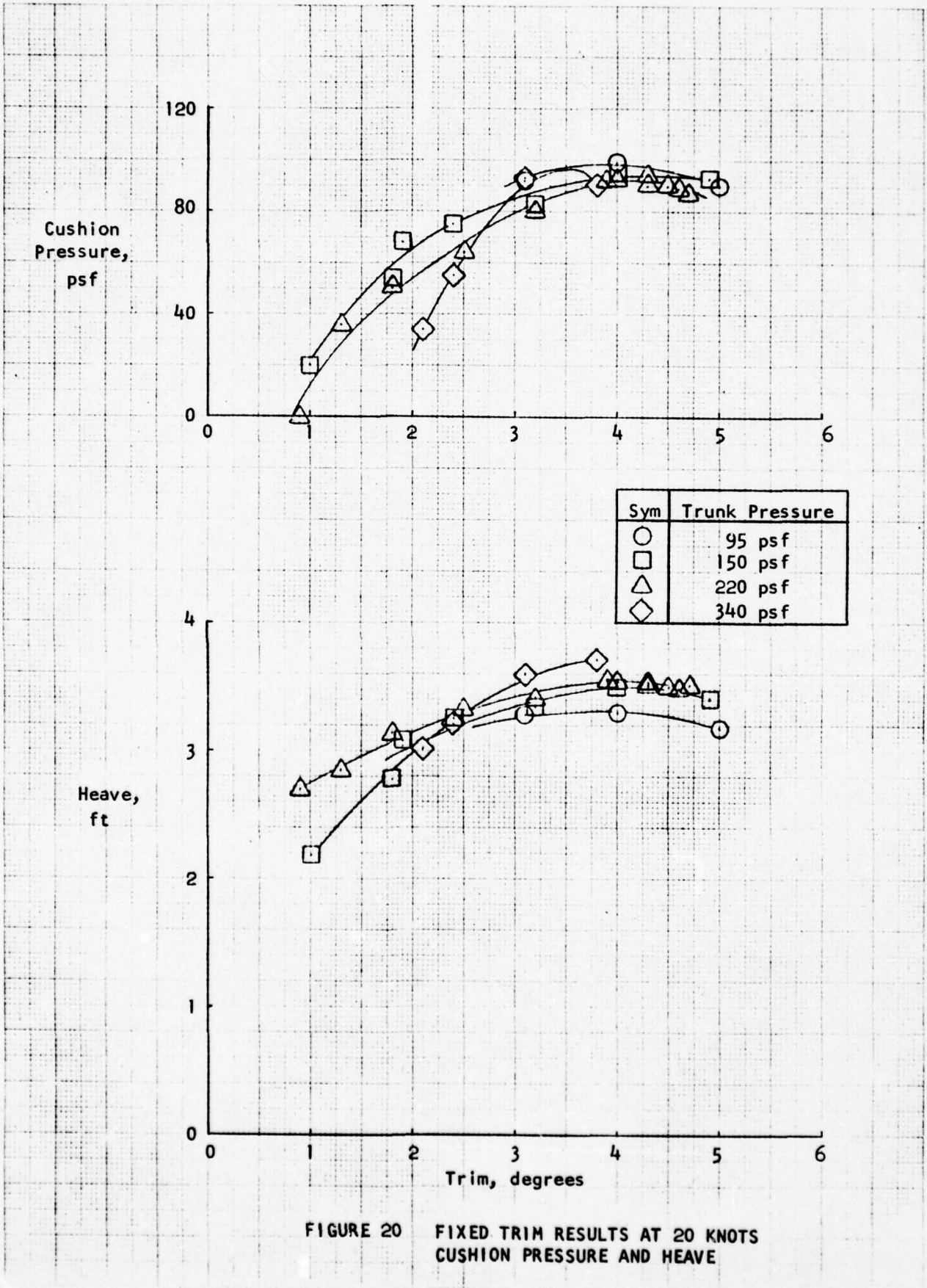


FIGURE 20 FIXED TRIM RESULTS AT 20 KNOTS
CUSHION PRESSURE AND HEAVE

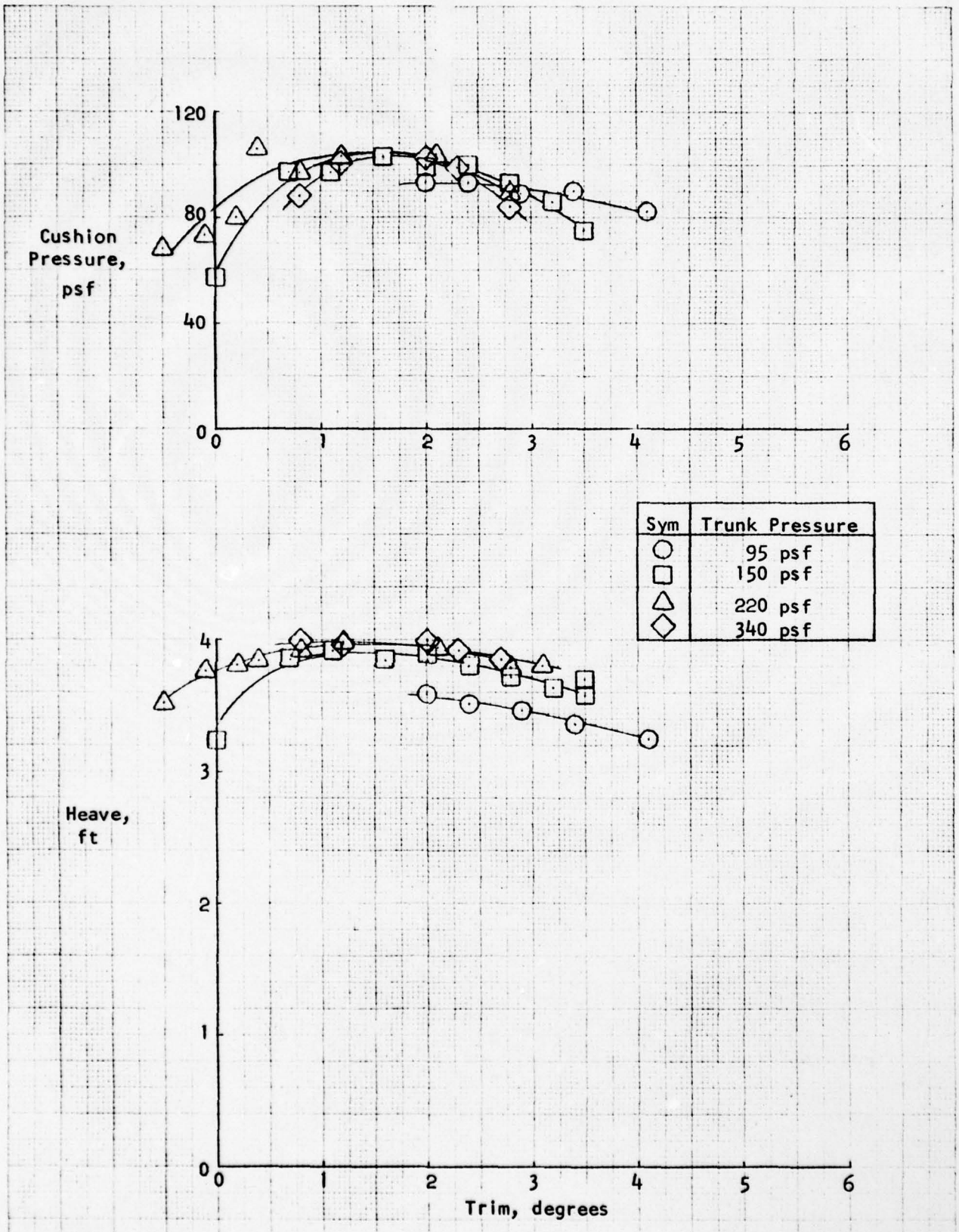


FIGURE 21 FIXED TRIM RESULTS AT 30 KNOTS
CUSHION PRESSURE AND HEAVE

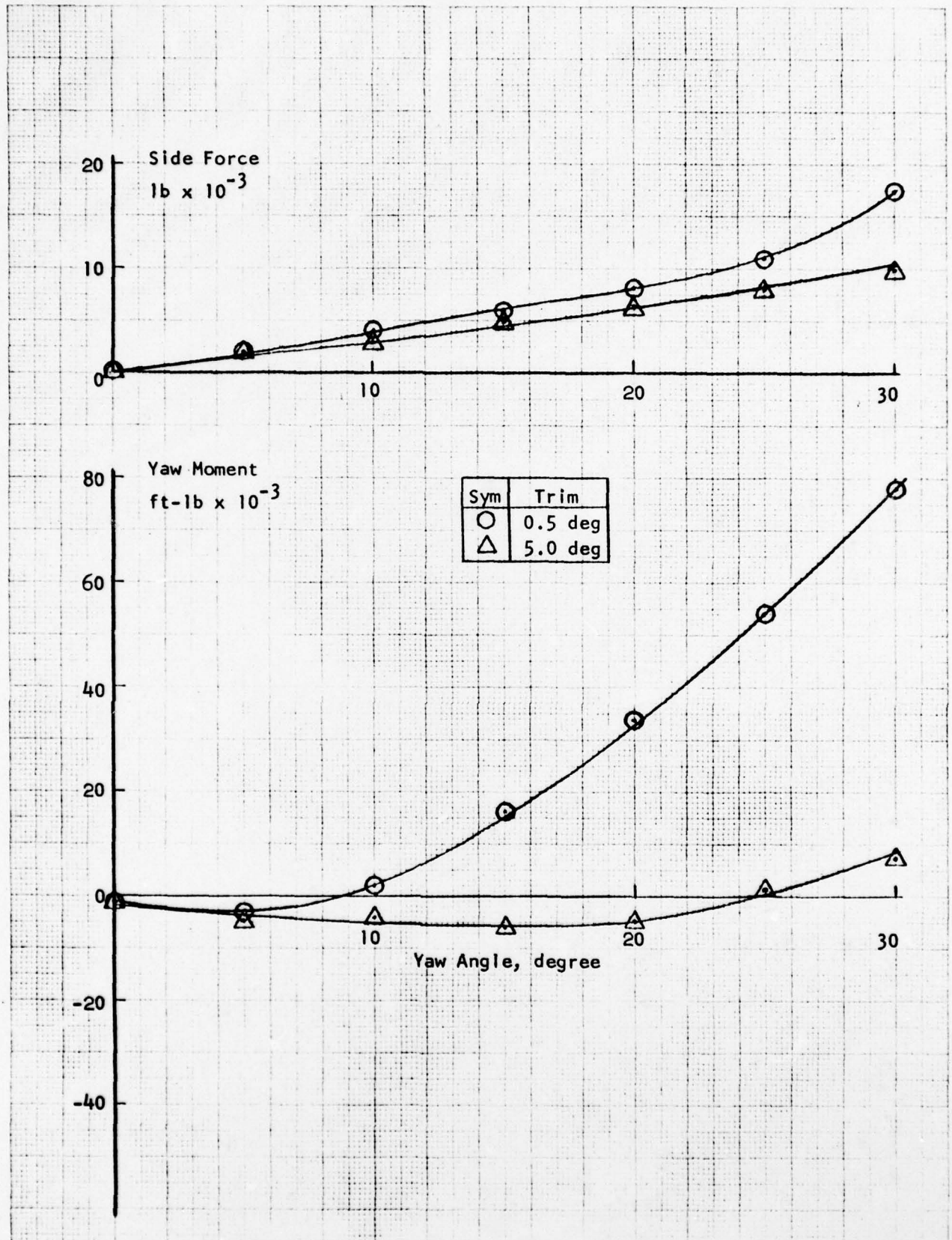


FIGURE 22 DIRECTIONAL STABILITY AT 11.7 KNOTS
NOMINAL TRUNK PRESSURE = 220 PSF

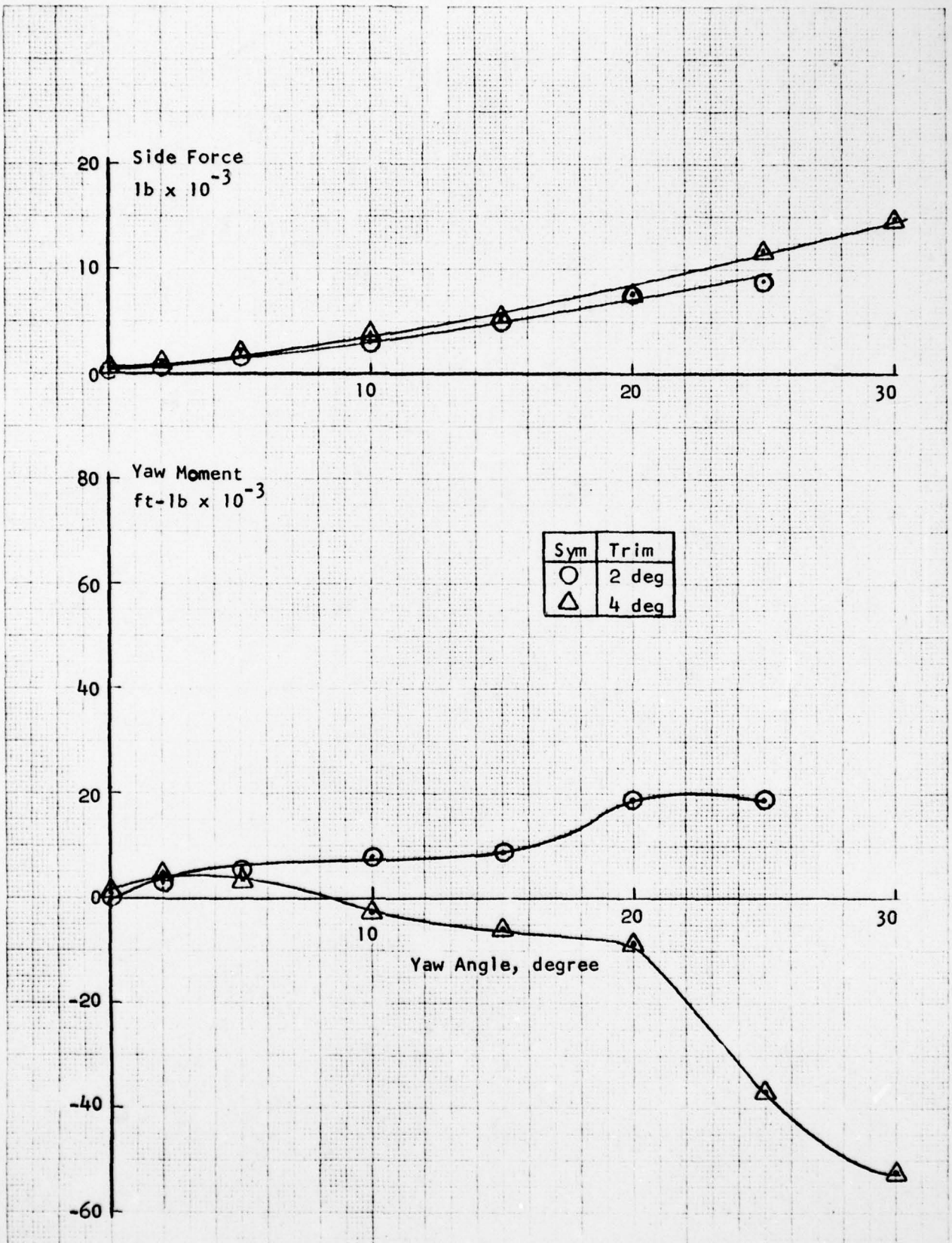


FIGURE 23 DIRECTIONAL STABILITY AT 20 KNOTS
NOMINAL TRUNK PRESSURE = 220 PSF

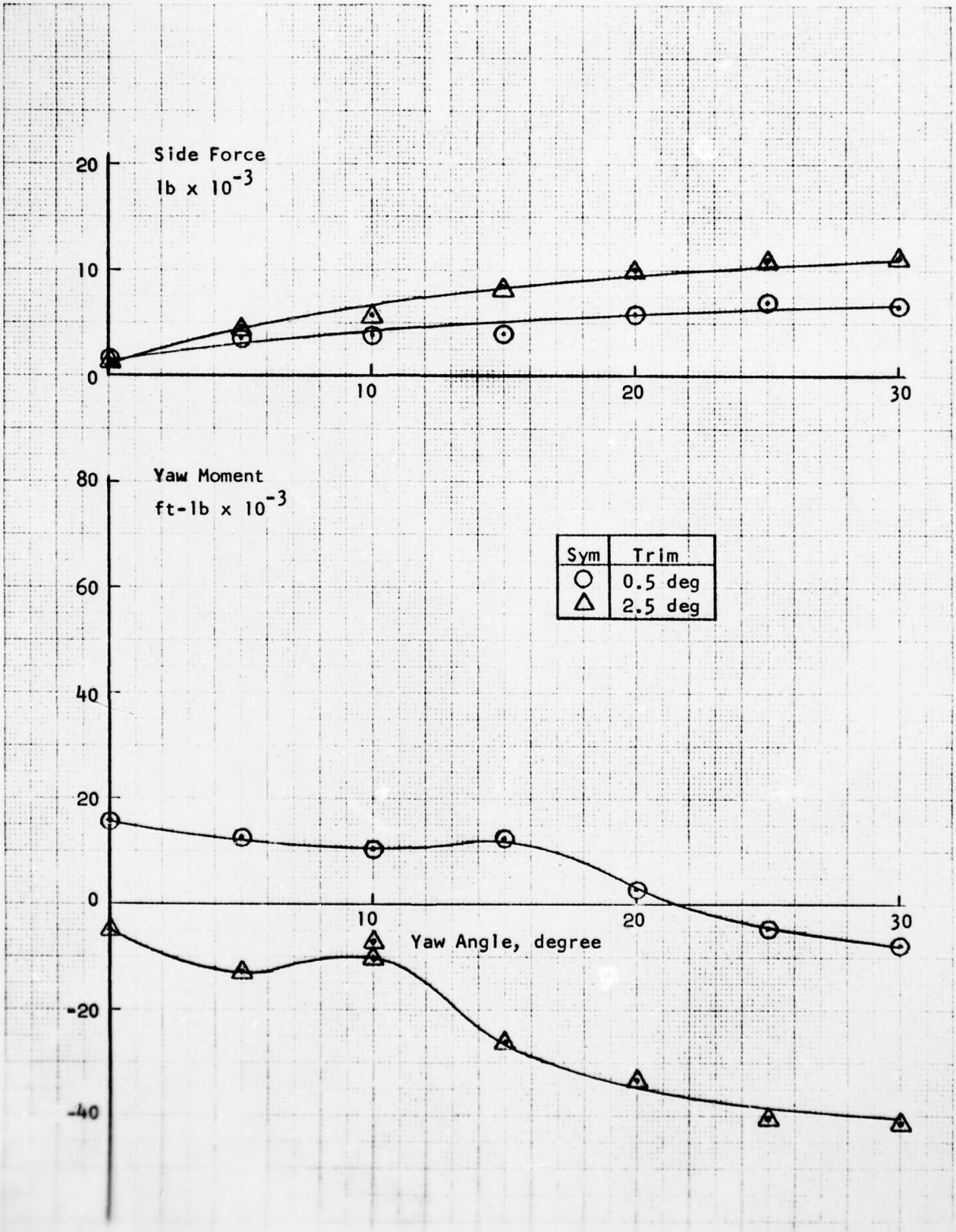


FIGURE 24 DIRECTIONAL STABILITY AT 30 KNOTS
NOMINAL TRUNK PRESSURE = 220 PSF

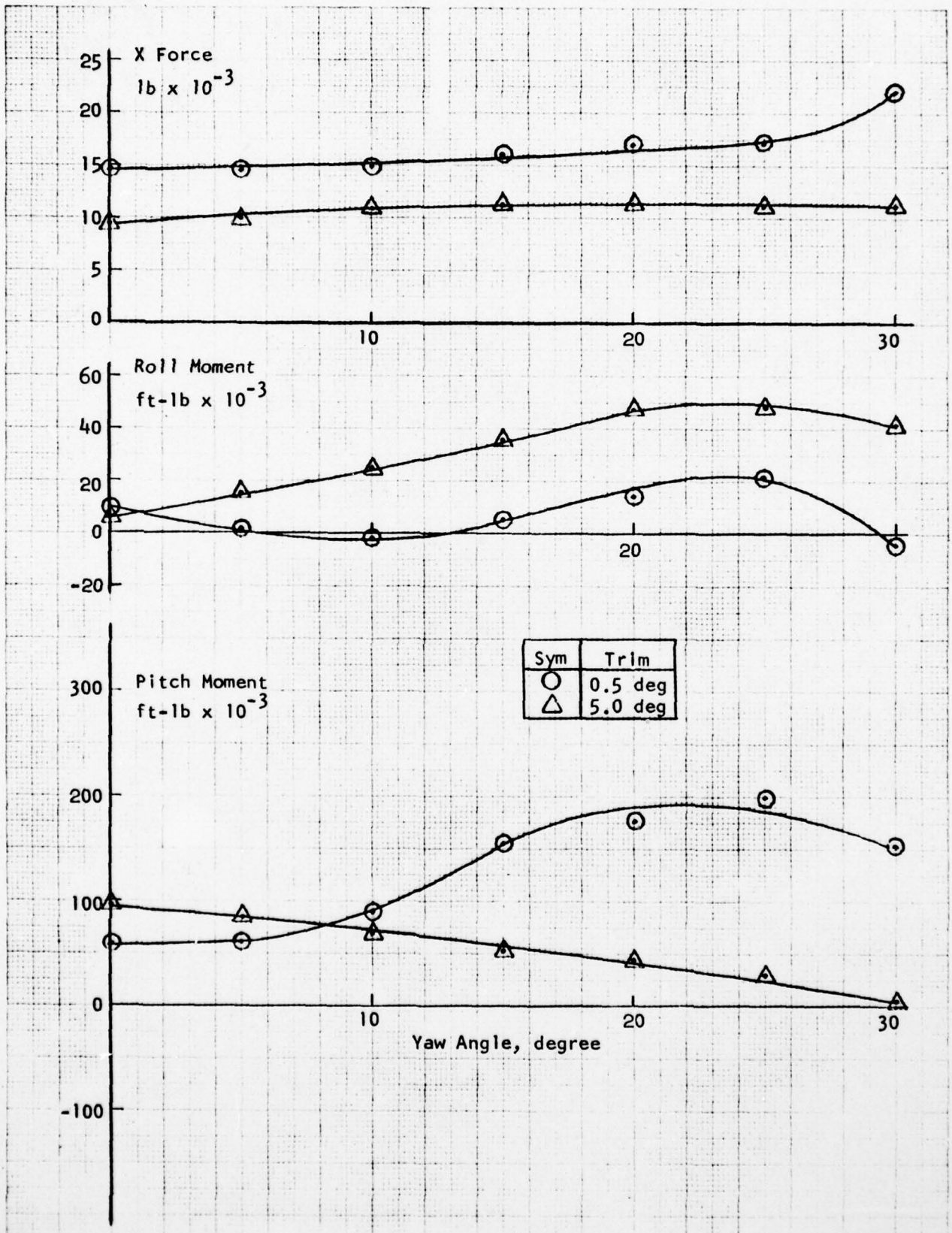


FIGURE 25 STABILITY RESULTS AT FIXED YAW AND 11.7 KNOTS
NOMINAL TRUNK PRESSURE = 220 PSF

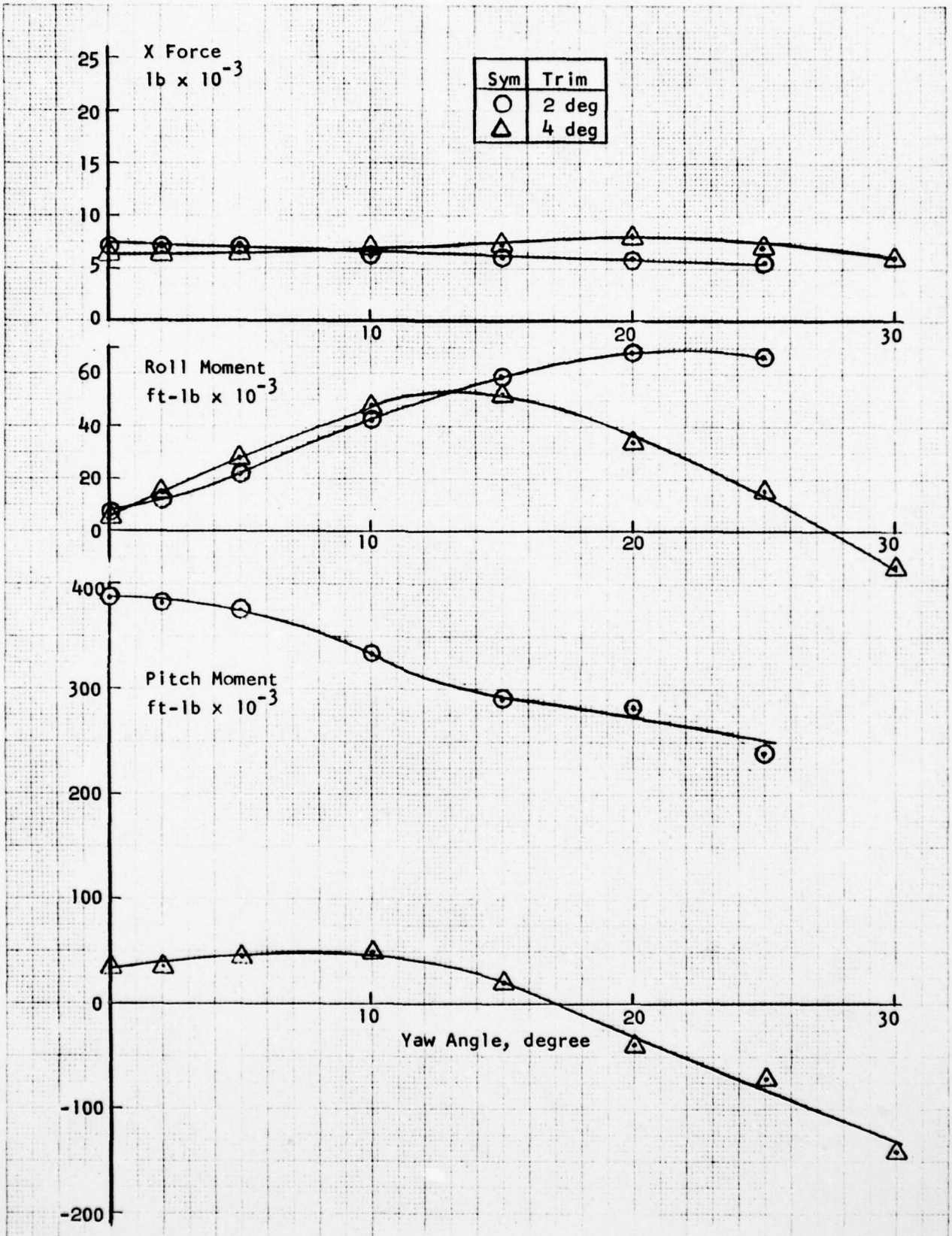


FIGURE 26 STABILITY RESULTS AT FIXED YAW AND 20 KNOTS
NOMINAL TRUNK PRESSURE = 220 PSF

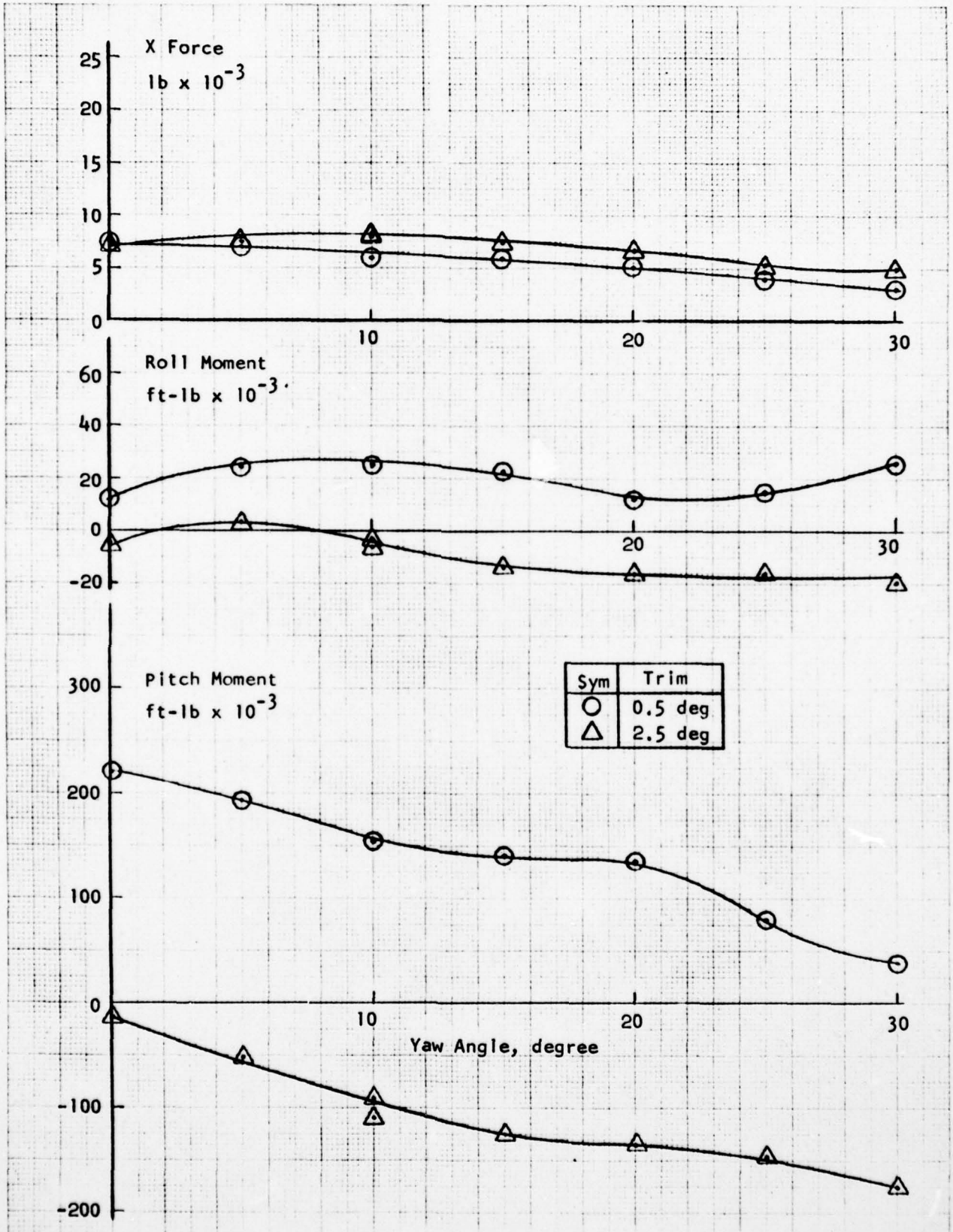


FIGURE 27 STABILITY RESULTS AT FIXED YAW AND 30 KNOTS
NOMINAL TRUNK PRESSURE = 220 PSF

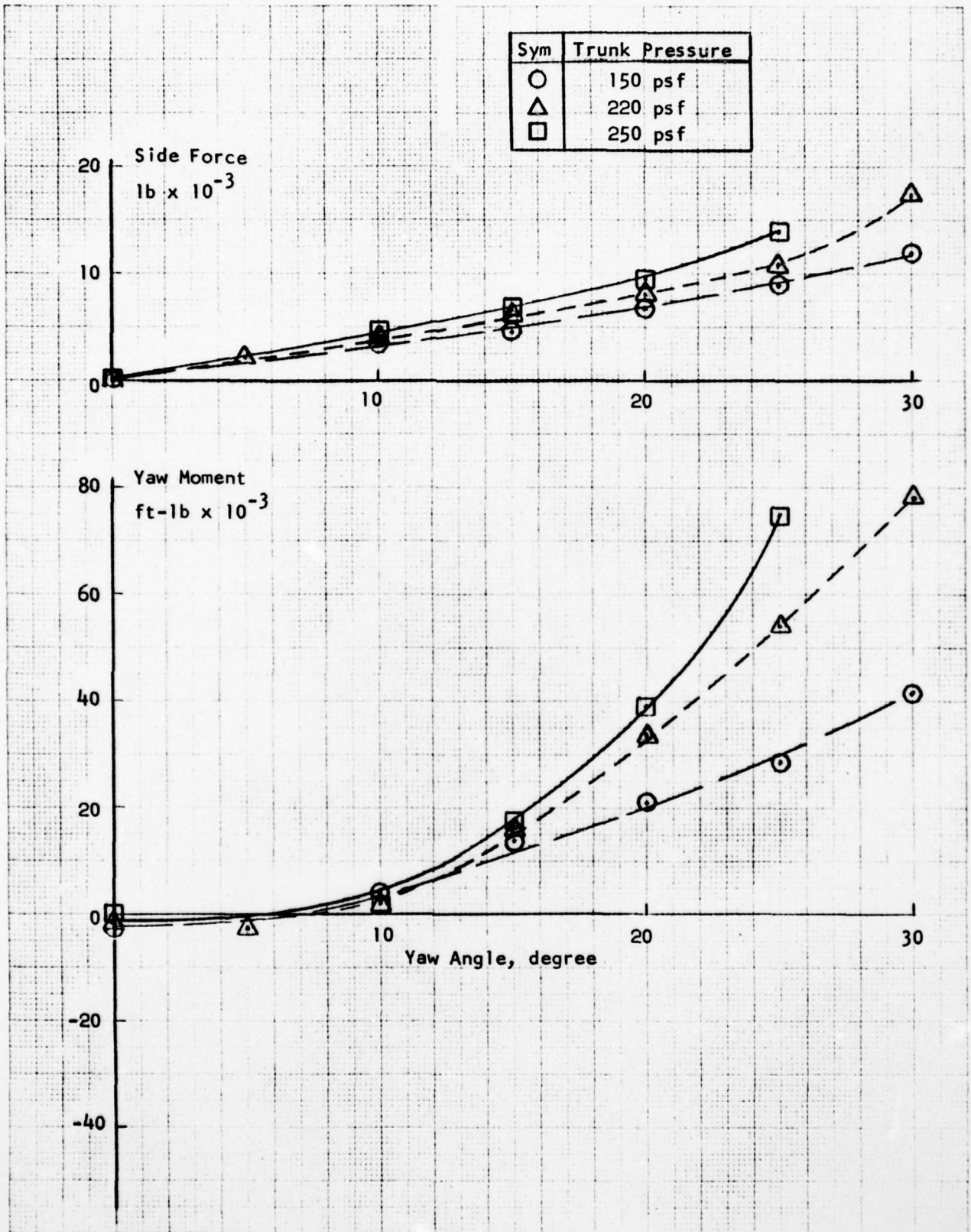


FIGURE 28 DIRECTIONAL STABILITY AT 11.7 KNOTS
NOMINAL TRIM = 0.5 DEGREE

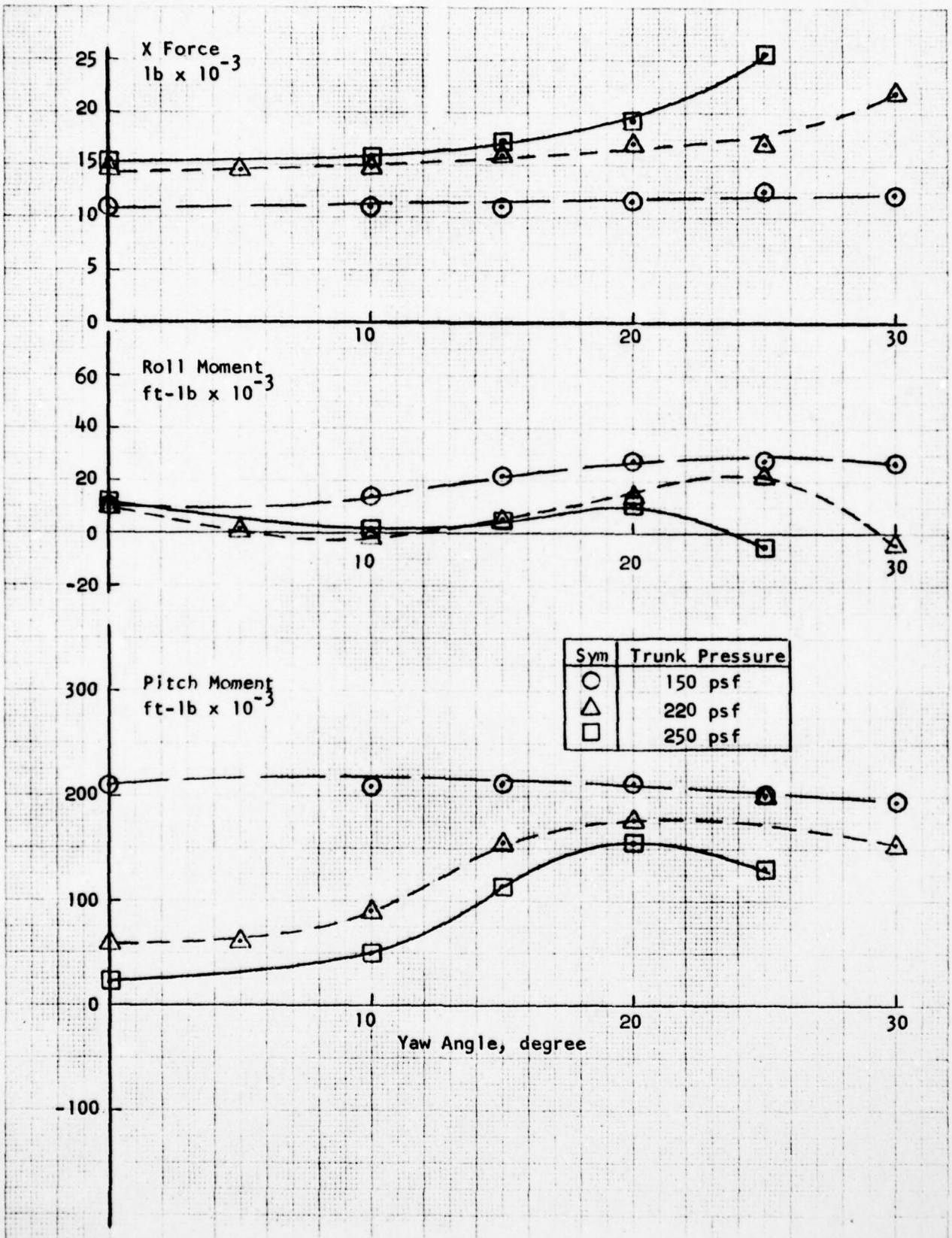


FIGURE 29 STABILITY RESULTS AT FIXED YAW AND 11.7 KNOTS
NOMINAL TRIM = 0.5 DEGREE

APPENDIX A

It has been noted in the main body of this report that the FSACV experiences an unacceptable ride quality in the area of the craft where troops will be transported. Specifically the 1/3-octave rms stern accelerations were shown to be above the ISO 1-hour FDP habitability standard. Tests have shown that lowering the trunk pressure accounted for reduced stern accelerations; however even at the lowest trunk pressure of 95 psf the ride quality was still unsatisfactory. Increasing the flow, and thereby lowering the fan pressure-flow slope (dP/dQ) by 50% (see Figure A-1) did not appear to effect the impact loads. Other ways to reduce the acceleration levels were tried; the text which follows summarizes what tests were done, and to what extent the results were successful.

Since it appeared that the trunk pressure excursions were possibly causing the high accelerations, poppet-type relief valves were considered for installation in the trunk. Their size and effectiveness were checked out by devising the calibrating rig shown in Figure A-2. The volume of the box represents the inflated trunk, and is pressurized by a single AXIMAX III fan at one end. The opposite end consists of a bellows arrangement which was compressed by having a falling weight suddenly close the initially extended volume. The resulting pressure rise time history was measured on an oscillograph by means of a standard pressure transducer. Four poppet valves were made each having an area of 1.5 square inches. The peak pressure and rms pressure were obtained from the oscillograph record and plotted as a function of valve area. Mean pressures of 10 and 13 psf were set (90 and 117 psf full size) and the compression in the spring, closing the valve, adjusted to lift at either the mean or 30% above the mean pressure. With all four valves active, peak pressures were reduced by 30%; and the rms pressures decreased by over 50%. Consequently, four of these valves were installed in the stern end of the FSACV model for the purpose of relieving the trunk pressure excursions. This represents a full scale pressure relief area of 3.4 ft^2.

Tests with a displacement of 56,000 lb were conducted at the 30 knot speed and in Sea State 2 ($H_{1/3}$ = 2.2 ft). The design LCG of 14.53 ft aft of Station 100 was used (12.84 ft forward of transom) in conjunction with a cushion flow of 1200 cfs. Combinations of mean trunk pressures and pressure relief settings on the valves were tested.

The results of this series indicated that the pressure relief system in the trunk was effective at the higher mean trunk pressures, but at a value of 90 psf the rms stern accelerations were identical with and without relief valves; see Table A-1, configurations "B" and "E".

Two cushion relief valves were then constructed and installed in the model. Each of these valves had an area of 5.4 sq.in.(3 ft^2 full size); and was mounted in the wet deck just forward of the LCG. They were adjusted to lift at a mean cushion pressure of 90 psf. No significant reduction in rms stern accelerations was observed.

The FSACV model craft appears to be pitching about the LCG by reason of the acceleration magnitudes which are considerably larger at the bow and stern that at the LCG. It was felt that if more pitch damping could be put into the craft, there would be a possible reduction in rms g's. Consequently, a flat plate hydrofoil (area = 13.5 ft^2, aspect ratio = 4) was mounted 4.7 feet below the wet deck at two longitudinal positions, forward and aft of the LCG. The results of this experiment revealed a sizeable increase in drag and reduced rms motions particularly with the foil at the forward knuckle. This latter configuration also had the lowest rms stern accelerations. The greatest reductions in rms stern acceleration were again at the higher trunk pressures (32% at P_T = 144 psf). At the lower trunk pressure of 90 psf, the percentage reduction was only 10%, still not enough to improve the habitability.

Additional attempts to run the FSACV model backwards, free-to-trim, with the LCG moved aft as far as possible (about 5 inches) were aborted due to diving behavior of the craft.

Tests were then run at fixed trim and various trunk pressures with the model at 0 and 180 degrees yaw angle. The trunk has a tapered configuration with a large volume forward (approximately 6 ft diameter at the bow)

and a small volume aft (approximately 4 ft diameter at the stern). This is the normal or 0 degree yaw condition. At 180 degrees yaw, the model is turned around to run backwards, thus reversing the relative trunk volumes. The purpose of these tests was to determine whether the width and diameter of the trunk at the bow would influence the habitability of the craft. The model was tested at the equivalent of 56,000 lb displacement, at 30 knots, in a Sea State 2 ($H_{1/3}$ = 2.2 ft). Table A-2 of rms CG accelerations summarizes the results of these tests. The letter "A" in the table means the model run was aborted due to excessive water ingested either in the fan plenum or over the bow/stern structure.

TABLE A-2

RMS CG ACCELERATIONS, g

YAW ANGLE = 0 DEGREE				
TRUNK PRESSURE PSF	TRIM, DEGREE			
	1°	2°	3°	4°
90		A		0.40
120	A	0.50	0.50	0.50
150	0.50	0.50	0.50	0.50
YAW ANGLE = 180 DEGREE				
90				A
120			0.43	0.43
150	A	0.43	0.43	0.43

These results indicate that the rms accelerations are independent of the trim angle and trunk pressures above 120 psf for both yaw angles. A 20% reduction in loads was realized at a trunk pressure of 90 psf with the model running forward. Turning the model 180 degrees to run backwards lowered the accelerations by 14%, which is not enough to significantly improve the habitability characteristics of the craft.

TABLE A-1

RESULTS OF CONFIGURATION STUDY TO REDUCE ACCELERATIONS

Displacement = 56,000 lb
Speed = 30 knots
Q = 1200 cfs
LCG = 14.53 ft
Sea State 2 - 2.2 ft significant wave height

	Mean Values				RMS Values				Accelerations		
Configuration	Trim degree	Heave ft	Drag lb	PC psf	Trim degree	Heave ft	PC psf	PT psf	Bow g	CG g	Stern g
TRUNK PRESSURE = 90 PSF											
A	3.3	3.5	8685	93	2.5	.41	75	48	.71	.45	.47
B	3.4	4.3	10182	59	2.2	.42	86	44	.67	.43	.42
C	3.9	4.2	10856	38	1.7	.35	50	47	.64	.40	.38
D	3.3	4.1	11081	85	2.1	.43	48	49	.71	.42	.40
E	3.3	4.2	10556	70	2.3	.39	77	41	.66	.40	.43
TRUNK PRESSURE = 117 PSF											
A	3.0	4.0	8385	85	3.3	.50	52	67	.94	.53	.69
B	3.0	4.7	8909	83	3.2	.54	59	64	.86	.55	.66
C	2.7	4.5	10631	48	2.4	.38	48	56	.71	.45	.50
D	2.6	4.4	10482	85	2.8	.51	53	70	.92	.50	.60
E	2.6	4.7	9209	85	2.9	.51	57	52	.78	.46	.65
TRUNK PRESSURE = 144 PSF											
A	2.8	4.2	8535	81	3.8	.50	54	83	1.10	.57	.82
B	3.2	4.9	9583	77	3.9	.56	87	82	1.00	.59	.79
C	2.8	4.6	10556	62	2.5	.39	51	62	.77	.47	.54
D	3.0	4.6	11230	81	3.3	.51	53	84	1.06	.55	.70
E	2.8	4.8	10032	81	3.4	.50	61	62	.85	.50	.70
F	2.6	4.6	10856	56	2.4	.44	50	52	.73	.43	.51

CONFIGURATIONS

A. Original baseline
B. Baseline with seams resewn and taped (trunk was stiffer after this repair was made)
C. Repaired baseline "B" with hydrofoil forward of LCG
D. Repaired baseline "B" with hydrofoil aft of LCG
E. Repaired baseline "B" with 4 active poppet-type valves in trunk
F. Combination of "C" and "E"

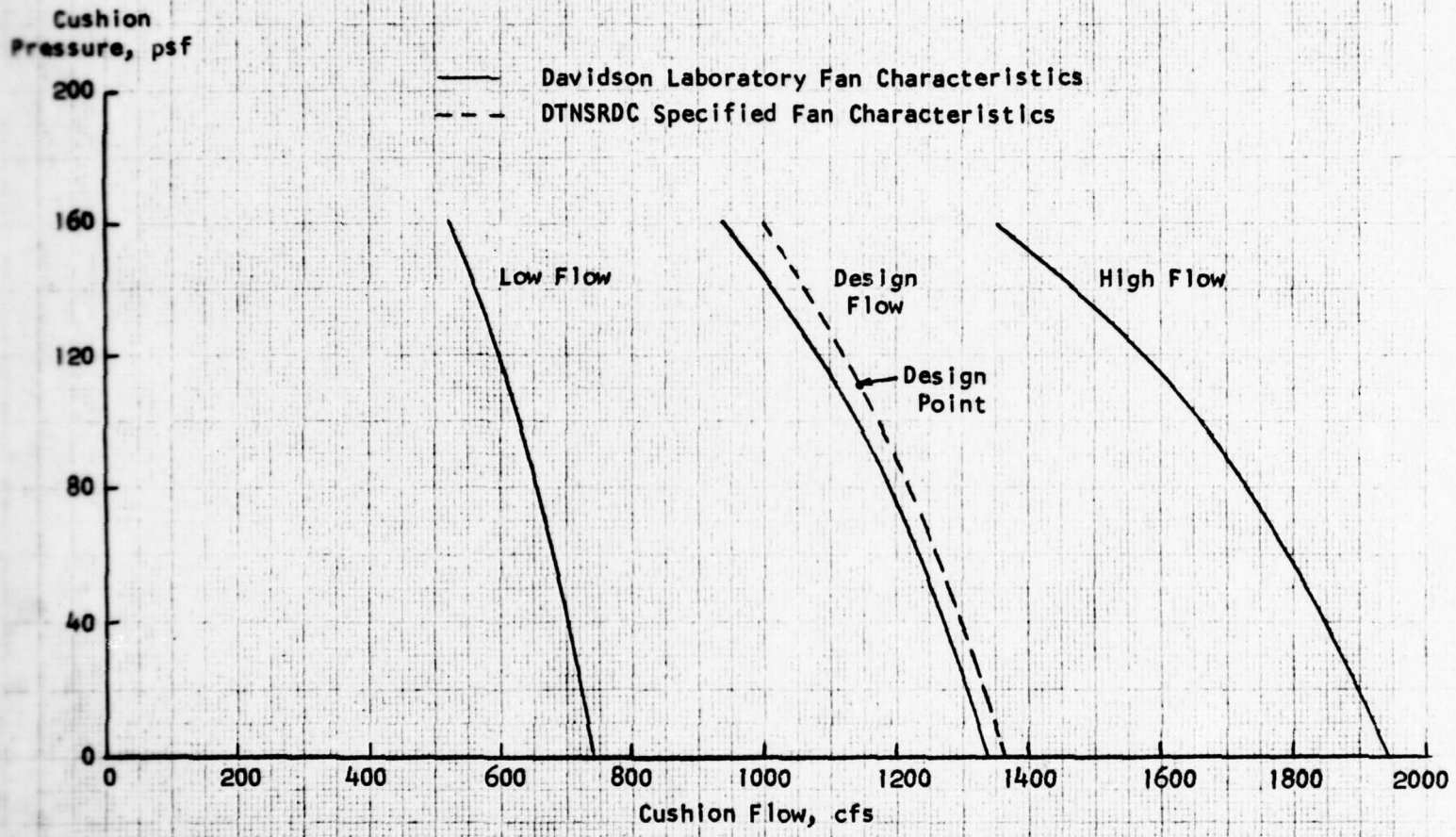


FIGURE A-1 COMPARISON OF PRESSURE-FLOW REQUIREMENTS

R-1921

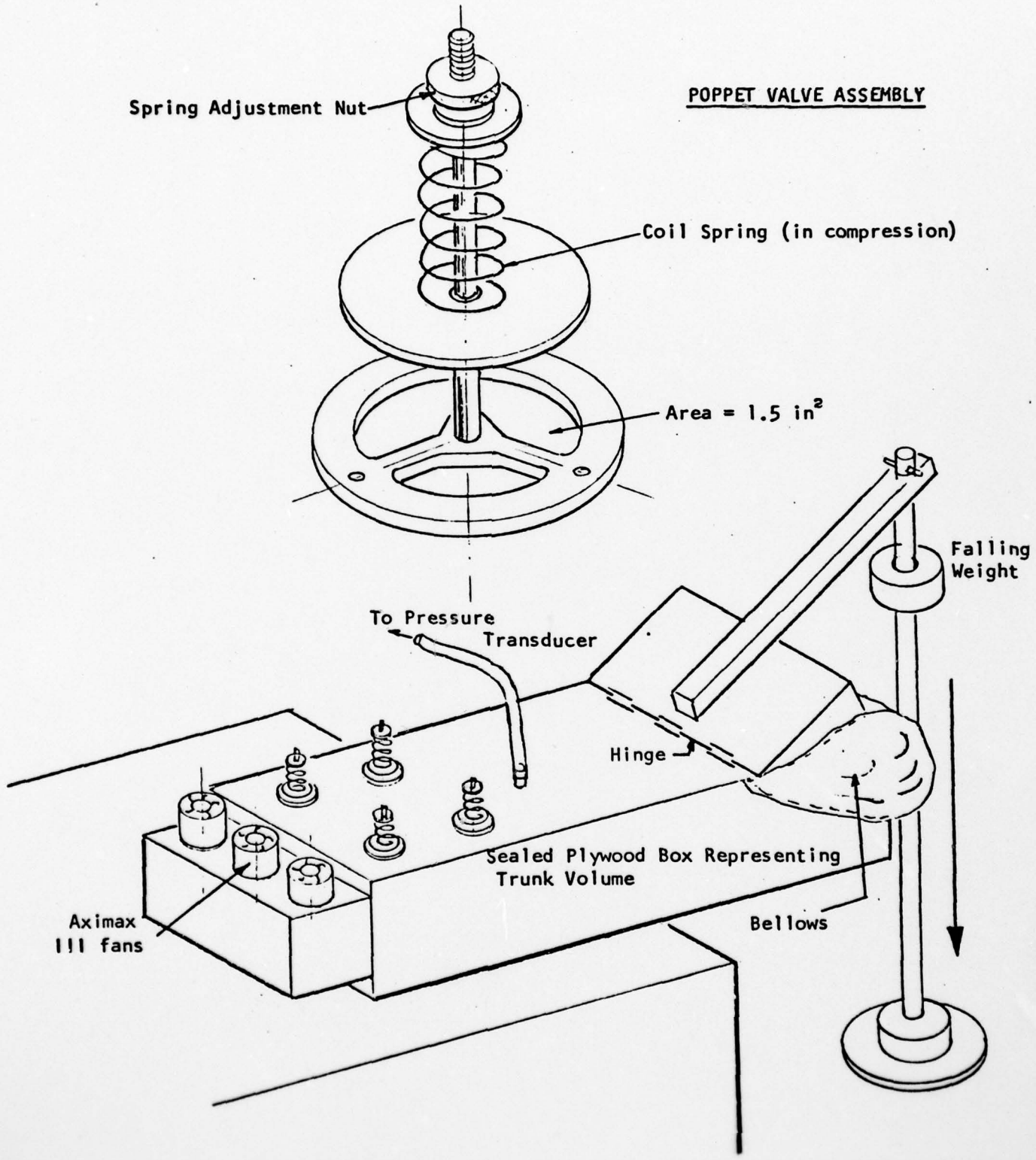


FIGURE A-2 - CALIBRATION APPARATUS FOR MEASURING EFFECTIVENESS OF PRESSURE RELIEF VALVES