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RESULTS OF FULL SCALE TRIALS ON TWO HIGH SPEED PLANING CRAFT (KUDU II AND KAAMA)

by

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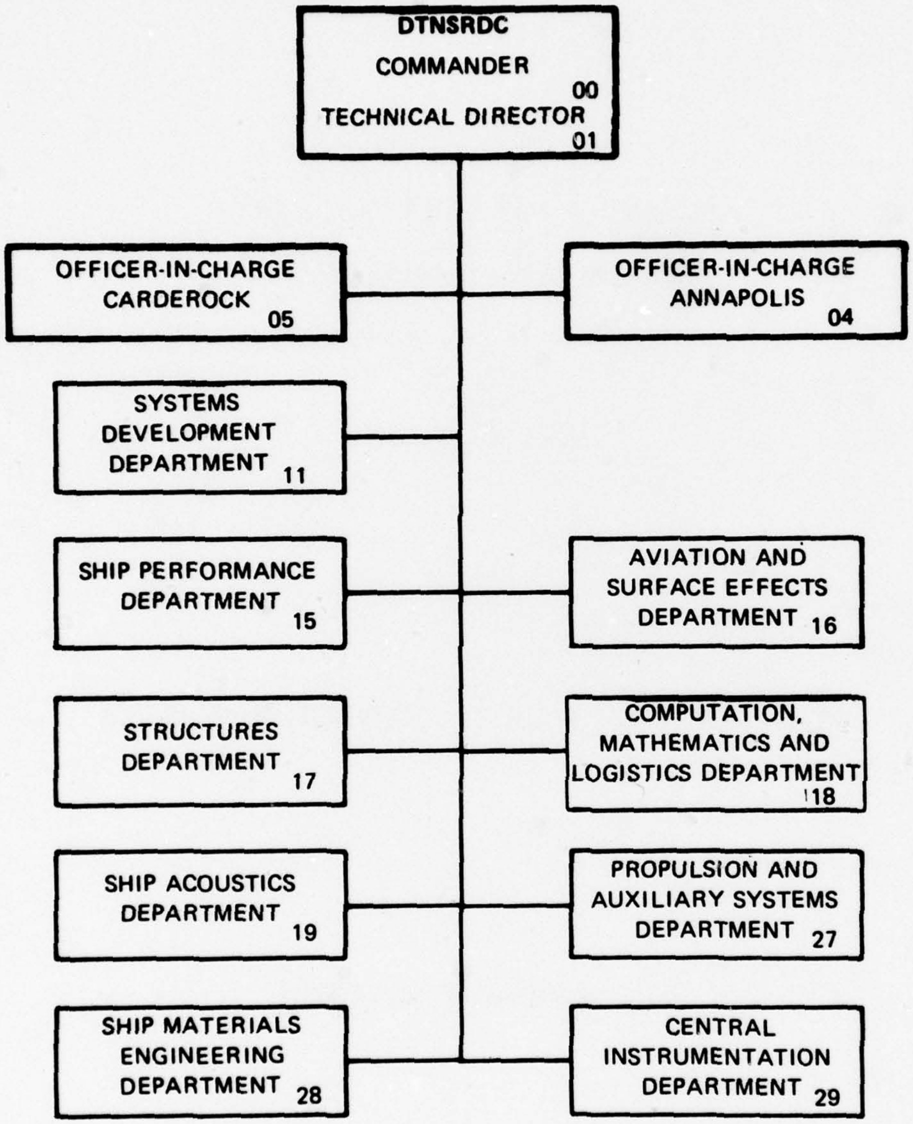

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Full scale trials were conducted on a ram wing planing craft and a conventional planing craft in a State 2 sea at various speeds and headings. Measurements were made of the seaway as well as craft motions and accelerations. Data on the ram wing craft, obtained in head seas only, indicates little difference in acceleration levels from that obtained on the conventional planing hull in the same seaway. Pitch motion for the ram wing craft was about 40 to 70 percent of that for the conventional planing hull.

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ABSTRACT

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ADMINISTRATIVE INFORMATION

This work was authorized and funded by the Naval Sea Systems Command and the Ship Performance and Hydromechanics Program, Task Area ZF 43 421 001, Work Unit Number 1500-102.

INTRODUCTION

Seakeeping trials were conducted on a ram wing planing craft and a conventional planing craft in order to compare the motions and accelerations of the two fundamentally different planing hull concepts. Though aerial motion pictures taken prior to these trials of both craft operating in the same seaway indicated that the ram wing craft experiences less severe motion than a conventional planing hull, accurate measurements of the crafts' motions had not been made.

The trials reported herein were conducted in the Pacific Ocean off Long Beach and Newport Beach, California in October 1977. Experiments were conducted in head, bow, stern quartering and following seas in Sea State 2 [significant wave height about 2.2 ft. (0.7m)] at speeds up to 60 knots (31m/s). Measurements were made of the seaway, each craft's pitch and roll, and vertical accelerations near the longitudinal center of gravity and near the bow. Significant double amplitudes of motions and accelerations as well as histograms of impact accelerations in head seas are reported.

CRAFT DESCRIPTION

The two planing craft used in these trials are owned by Kudu Aeroseacraft Corporation of Costa Mesa, Califonia. KUDU was also under contract toman the craft and to provide technical assistance during the conduct of the trials. The 35 ft. (10.7m) ram wing planing craft, KUDU II, was designed and built by Kudu. A schematic of this craft is shown in Figure 1. This particular ram wing concept is composed of a planing hull split down the centerline into two sponsons which are then attached to the ends of a wing section to form the ram wing planing craft. Specifications of KUDU II are given in Table 1 while craft dimensions are shown in Figure 1. The craft, fitted to carry four occupants, is fabricated of aluminum honeycomb and wood. The longitudinal center of gravity (LCG) is about 7.5 ft. (2.3m) forward of the transom and the deadrise at the transom is 13 degrees. Data from smooth water trials conducted on the craft at 70 knots (36 m/s) in 1975 indicate that about one-third of the craft's weight is carried by the wing section.

The 36 ft. (11.0m) conventional deep-sea planing hull used in these trials, KAAMA I, was designed and built by Cigarette of Miami, Florida. Specifications of KAAMA I are given in Table 1 while craft dimensions are shown in Figure 2. KAAMA I, fitted to carry three occupants, is constructed of wood and fiberglass in resin. The LCG is about 10 ft. (3m) forward of the transom and the deadrise at the transom is 25 degrees.

DESCRIPTION OF MEASUREMENTS AND INSTRUMENTATION

Measurements were made of craft motions and acceleration as well as of the seaway. Pitch, roll and vertical acceleration near the LCG were measured by a stabilized platform developed by David W. Taylor Naval Ship Research and Development Center for use by the U.S. Coast Guard to measure buoy motions. A nonstabilizing 50 g accelerometer was mounted near the bow to measure rigid body vertical accelerations near the bow. The seaway was measured by a free floating buoy which telemetered wave data to a support craft for recording.

The data measured by the USCG Buoy Motion Measurement System is conditioned and multiplexed by the system and transmitted to a data receiver located on the support craft. This data was recorded on analog tape in both multiplexed and demultiplexed form. The demultiplexed data was also recorded on strip chart. In multiplexed form, the Coast Guard Motion Measurement System is capable of handling data from as many as seven measurement packages.

TRIAL PROGRAM AND PROCEDURE

The trial program for the KUDU and KAAMA consisted of experiments conducted at four headings to the predominant direction of the seaway at three speeds in Sea State 2 as detailed in Table 2. Approximately 10 to 15 minutes of data was collected for each test condition. The trials were run in the Pacific Ocean off Long Beach and Newport Beach, California, about 5 miles (8 km) from shore where the water depth was at least 120 ft. (37m).

Prior to beginning each day's trials, the wave height buoy was deployed in the trial area. Wind direction was established and used as a reference for the predominant seaway direction. Preliminary runs indicated the transmitting range for the motion measurement package aboard the test craft to be about 2.5 miles (4 km). Therefore, the starting point for each run was about 2.5 to 3 miles from the support craft. For each run the craft was steadied on course and speed and the demultiplexed data monitored on the strip chart to determine which portion of the data would be analyzed. After a particular run was completed, the test craft operator reported to the support craft via radio that the craft would run a reciprocal course for a predetermined length of time in order to return to the original starting point. Thus for each run the craft and wave buoy were in the middle of the test course. Repeat runs were made for all experimental conditions so that sufficient data was recorded to yield statistically reliable results.

TRIAL RESULTS

The data obtained during these trials was analyzed both in the frequency and time domains. This analysis yields mean values, energy spectra, histograms as well as statistical information about the time histories. The data presented in this report are the significant double amplitudes (average of the one third highest peak to peak excursions) of craft motions and accelerations.

Figure 3 presents the sea spectrum from a 50 minute seaway data record obtained during the first day of trials off Long Beach, California. Seaway data for the second day of trials is not available due to an inoperable wave height receiver. In general, the seaway was about the same during both days of operation, characterized by 3 to 5 ft. (.9 to 1.5m) swells with about 1 ft. (.3m) wind chop. The seaway was more nearly unidirectional on the first of the two trial days.

Figure 4 presents significant double amplitudes of motions for both KUDU and KAAMA operating in a Sea State 2 at various speeds and headings. Pitch motion for the KAAMA increases with speed in head seas while pitch for KUDU in head seas changes little with speed. Pitch for the KAAMA in quartering seas changes little with speed. The double amplitudes of vertical accelerations are the gross values of the rigid body accelerations and do not reflect acceleration due to impacts. Vertical acceleration near the LCG and near the bow show little speed effect in the 40 to 60 knot range to either craft. It should be noted that pitch amplitude for the KUDU is only about 74% of that for the KAAMA in head seas at 42 knots and 43% at 61 knots.

Data on the KUDU was obtained in head seas only since the craft suffered mechanical difficulties and minor structural damage to the wing section during the first day of trials. The trial program on the KAAMA was completed on the second day of trials.

Figure 5 presents the same data shown in Figure 4, but plotted as a function of heading for various speeds. Roll for the KAAMA is about the same for all headings at a given speed where sufficient data exists to make a comparison. KAAMA pitch is about the same for all headings at 43 knots, is largest in bow seas at 52 knots and largest in head seas at 61 knots. Vertical acceleration near the LCG and near the bow for the KAAMA is about the same for all headings at a given speed.

Impact accelerations were read manually from strip chart records of time histories for both craft operating in head seas at 43.5 and 60.8 knots. Figures 6a and 6b show typical time histories of craft accelerations and define the amplitude of an impact acceleration. The rise time of the impacts was in order of 0.02 seconds.

Figures 7 and 8 present histograms of the impact acceleration amplitudes at the LCG and near the bow, respectively. The ordinate is the percentage of the samples that fall within a particular "g" range while the abscissa is the particular "g" range interval into which the samples were divided. For example, in Figure 7, approximately 22 percent of the impact accelerations at the LCG experienced by the KUDU in head seas at 43.5 knots fall within the 2.0 to 2.4 "g" range. In general, the distribution of impact accelerations is about the same for both craft at 43.5 knots. However, the KAAMA experienced somewhat higher impact accelerations at 60.8 knots than did the KUDU. For example, about 43 percent of the impact accelerations at the LCG on the KAAMA were above 3 g's while only about 16 percent of the LCG impact accelerations on the KUDU exceeded 3 g's.

CONCLUSIONS AND RECOMMENDATIONS

Due to the damage sustained by the ram wing planing craft KUDU during the first day of trials, there is little data available from which comparison of its performance relative to that of the conventional planing craft can be made. The data does suggest that the KUDU pitch motion in head Sea State 2 around 40 to 60 knots is significantly lower than that for the KAAMA. It is therefore recommended that additional trials be run on both craft to further characterize the relative performance of both type planing craft at headings other than head seas.

Experience gained in the use of the Coast Guard Motion Measurement System for small craft trials suggests that the system is very well suited for this type of trial work. Installation is very quick and simple and the eight channel capability could be easily expanded where necessary. It is, however, recommended that the transmitting power be increased on these units to extend the range of the equipment. It is also recommended that additional systems should be built around the existing equipment so that other types of measurements could be accommodated by this system (for example, slamming pressures, loads, craft velocity, engine rpm, etc.).

TABLE 1

	KUDU II	KAAMA I
Length Overall, LOA ft (m)	35 (10.7)	36 (11.0)
Beam, ft (m)	13.8 (4.2)	9.7 (3.0)
Displacement, lbs (kg)	10,800 (4898)	10,000 (4535)
Installed Power, H.P. (kw)	1300 (970)	1200 (895)
Longitudinal Center of Gravity LCG, forward of transom, ft (m)	7.5 (2.3)	10 (3.0)
Stabilized Platform forward of transom, ft (m)	8.5 (2.6)	10 (3.0)
Bow Accelerometer, forward of transom, ft (m)	28.9 (8.8)	31.2(9.5)

TABLE 2

SPEED knots	HEADINGS			
	180^{o} (Head)	135^{o} (Bow Q)	45^{o} (Stern Q)	0^{0} (Following)
Dead slow	KUDU KAAMA			
43.5	KUDU KAAMA	KAAMA	KAAMA	
52.1	KAAMA	KAAMA	KAAMA	KAAMA
60.8	KUDU KAAMA	KAAMA	KAAMA	

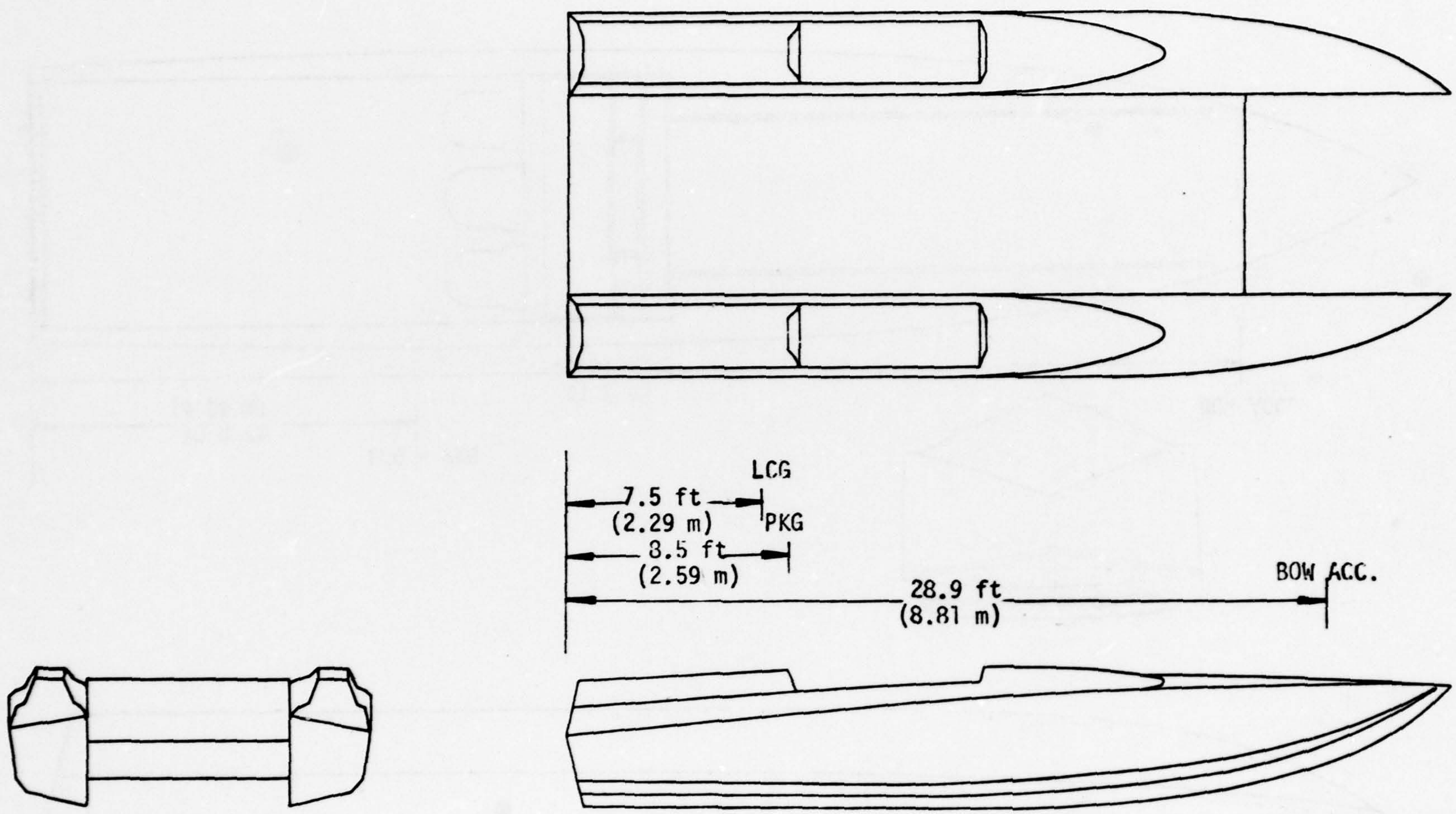

Figure 1 - KUDU II

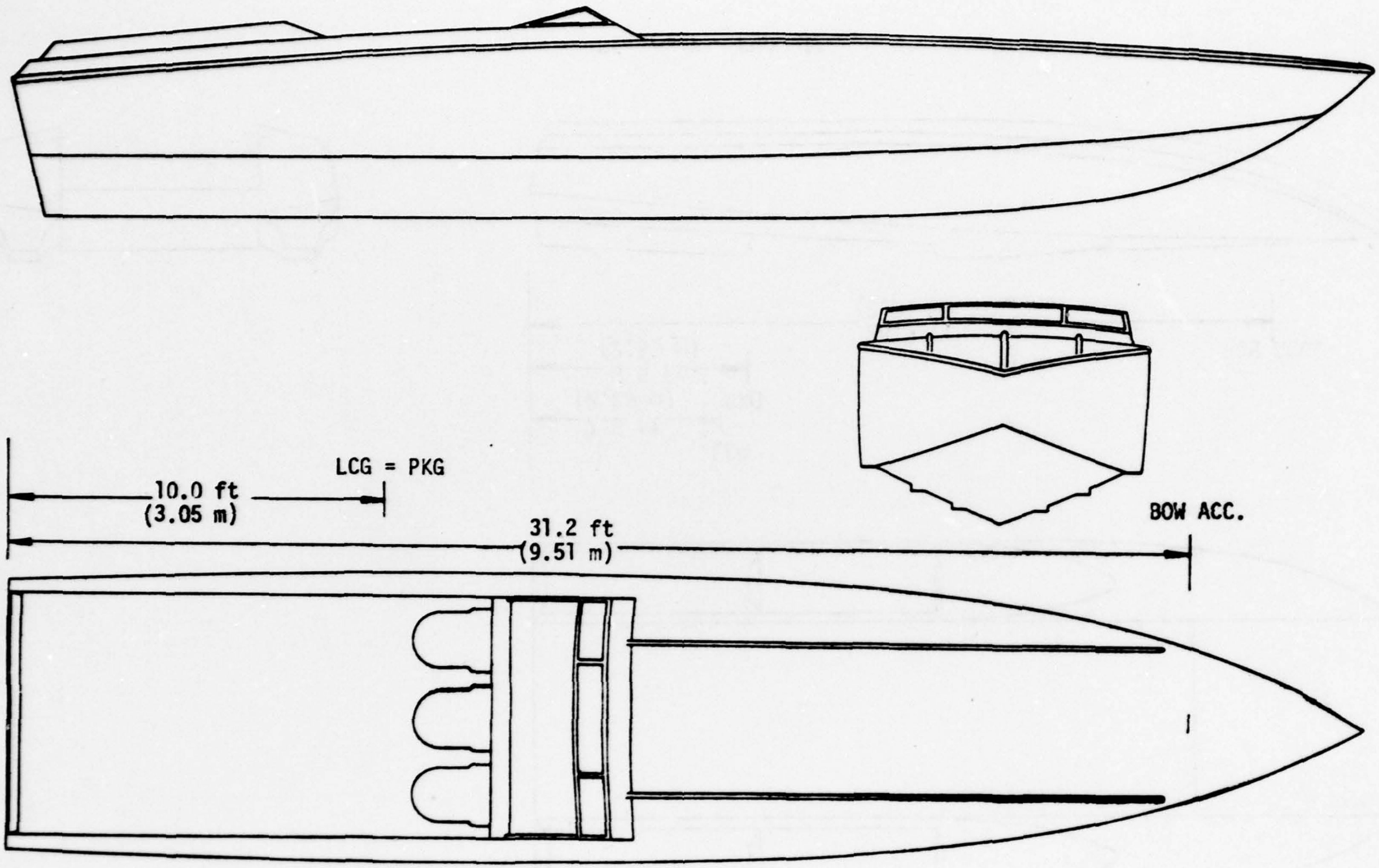

Figure 2 - KAAMA

KUDU FULL SCALE TRIAL
SEA SPECTRUM AT LONG BEACH

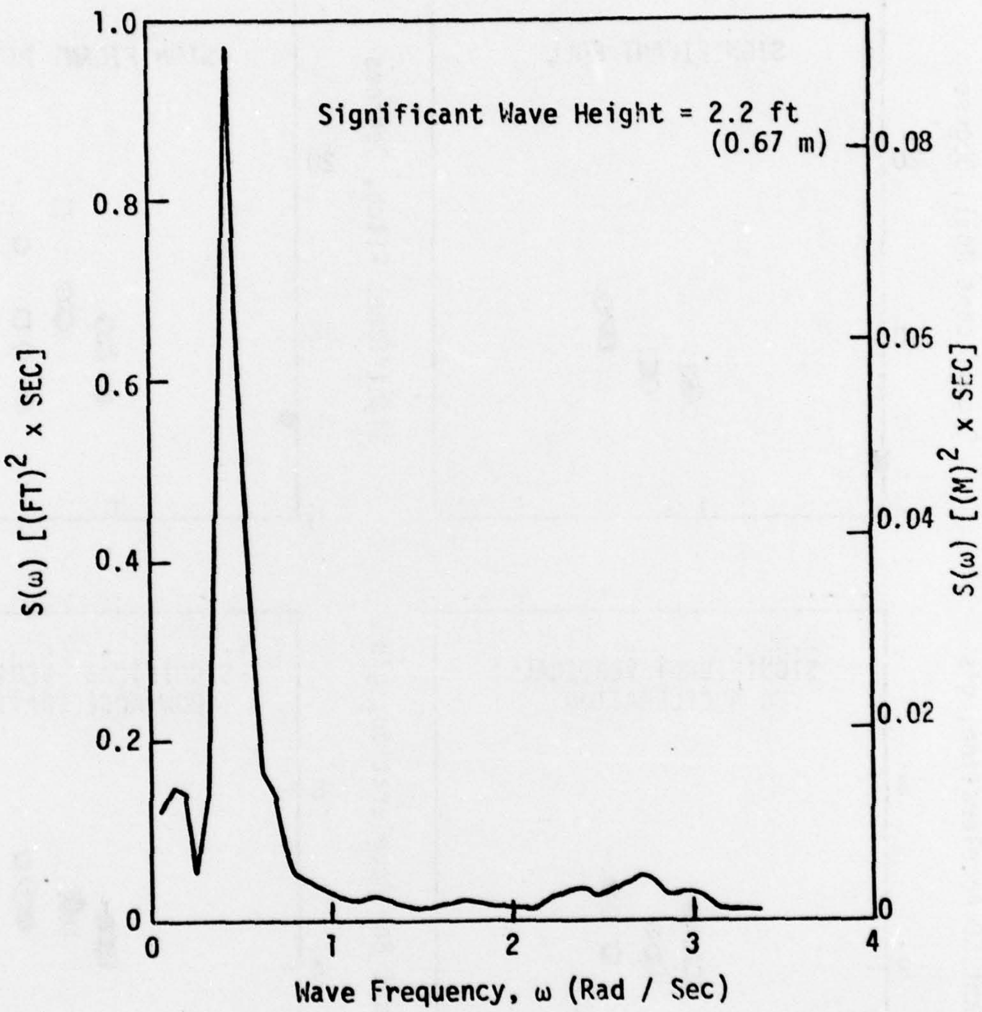

Figure 3 - Sea Spectrum

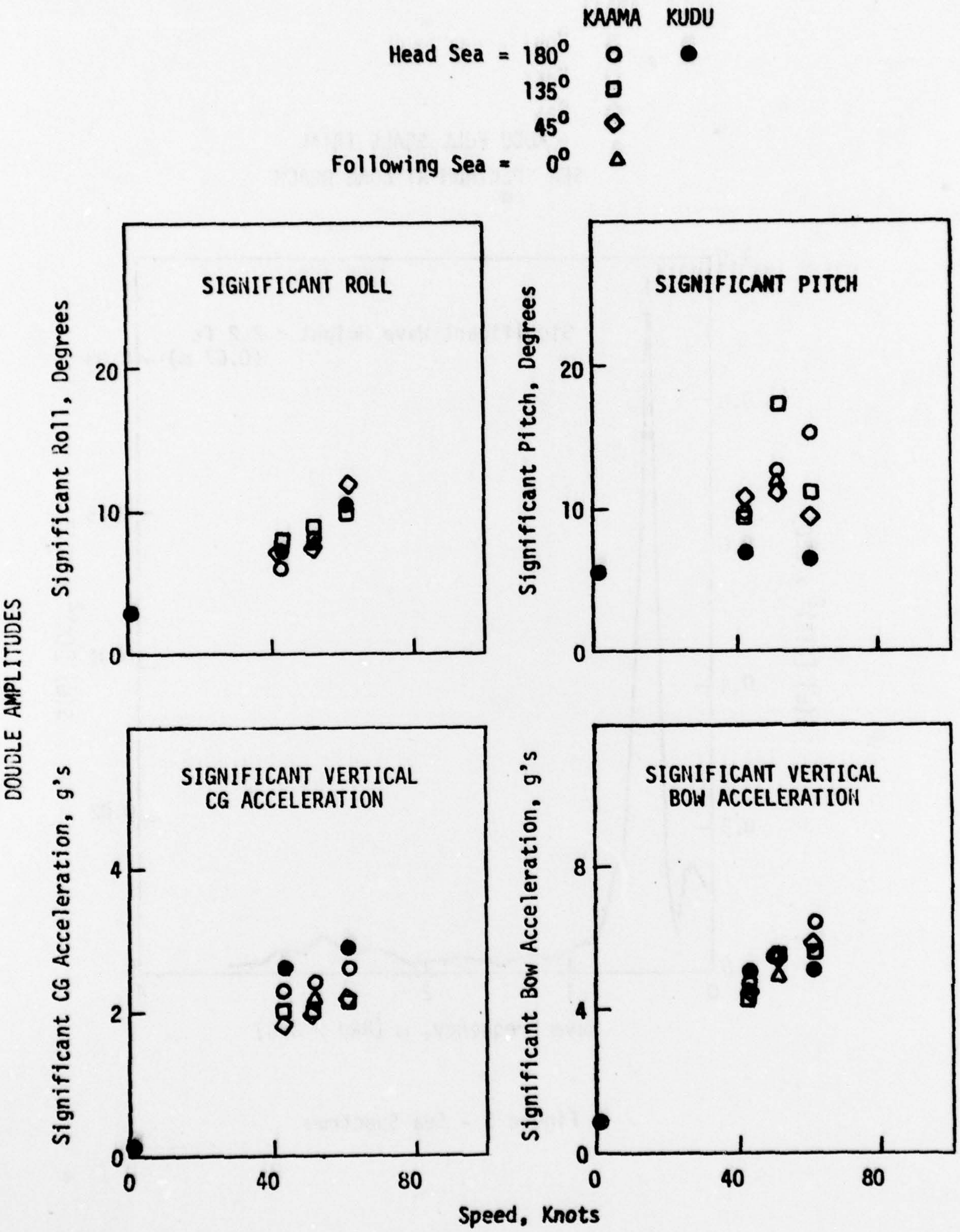

Figure 4 - Significant Double Amplitudes of Motions and Accelerations as a Function of Speed

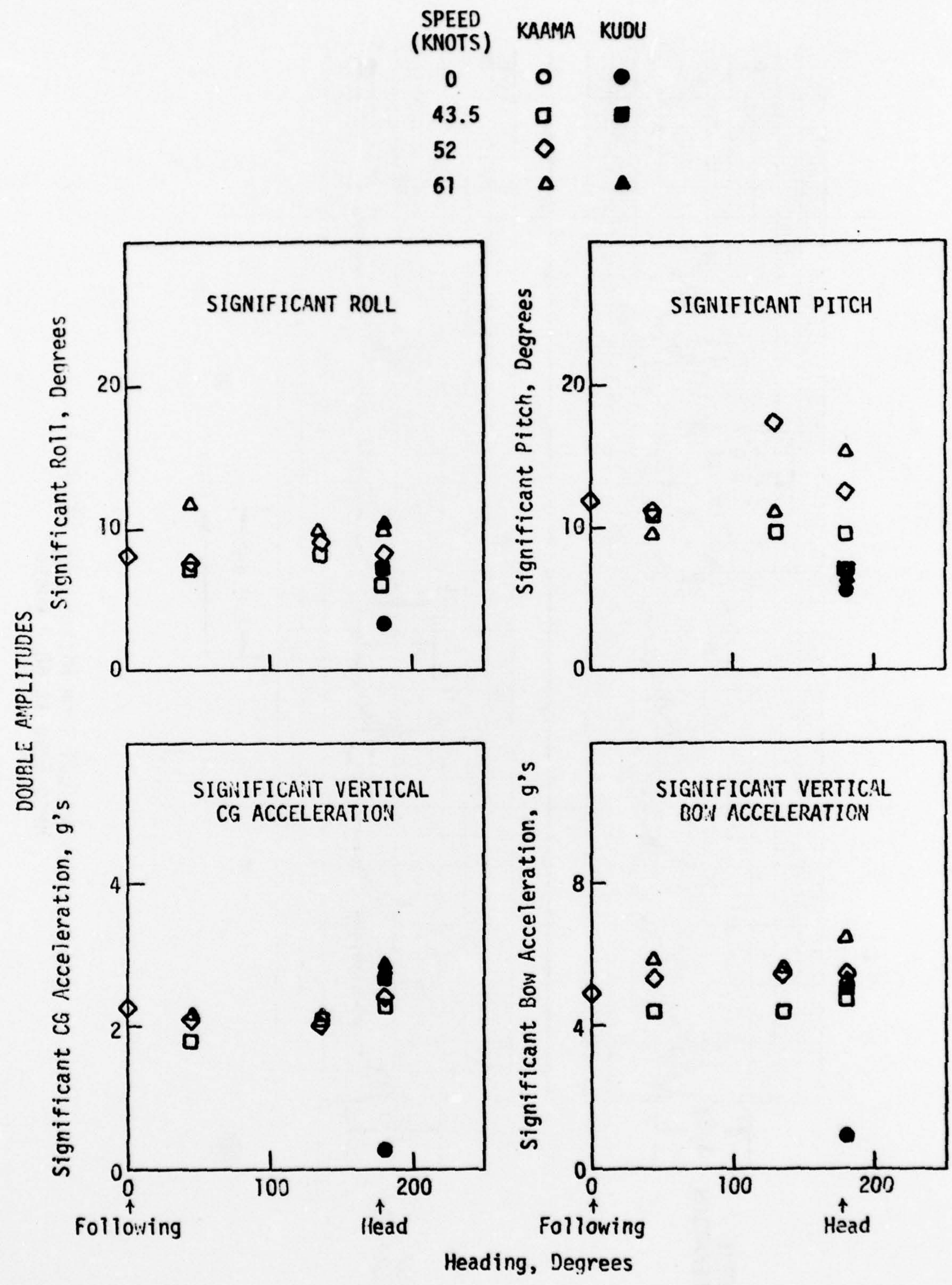

Figure 5 - Significant Double Amplitudes of Motions and Accelerations as a Function of Heading

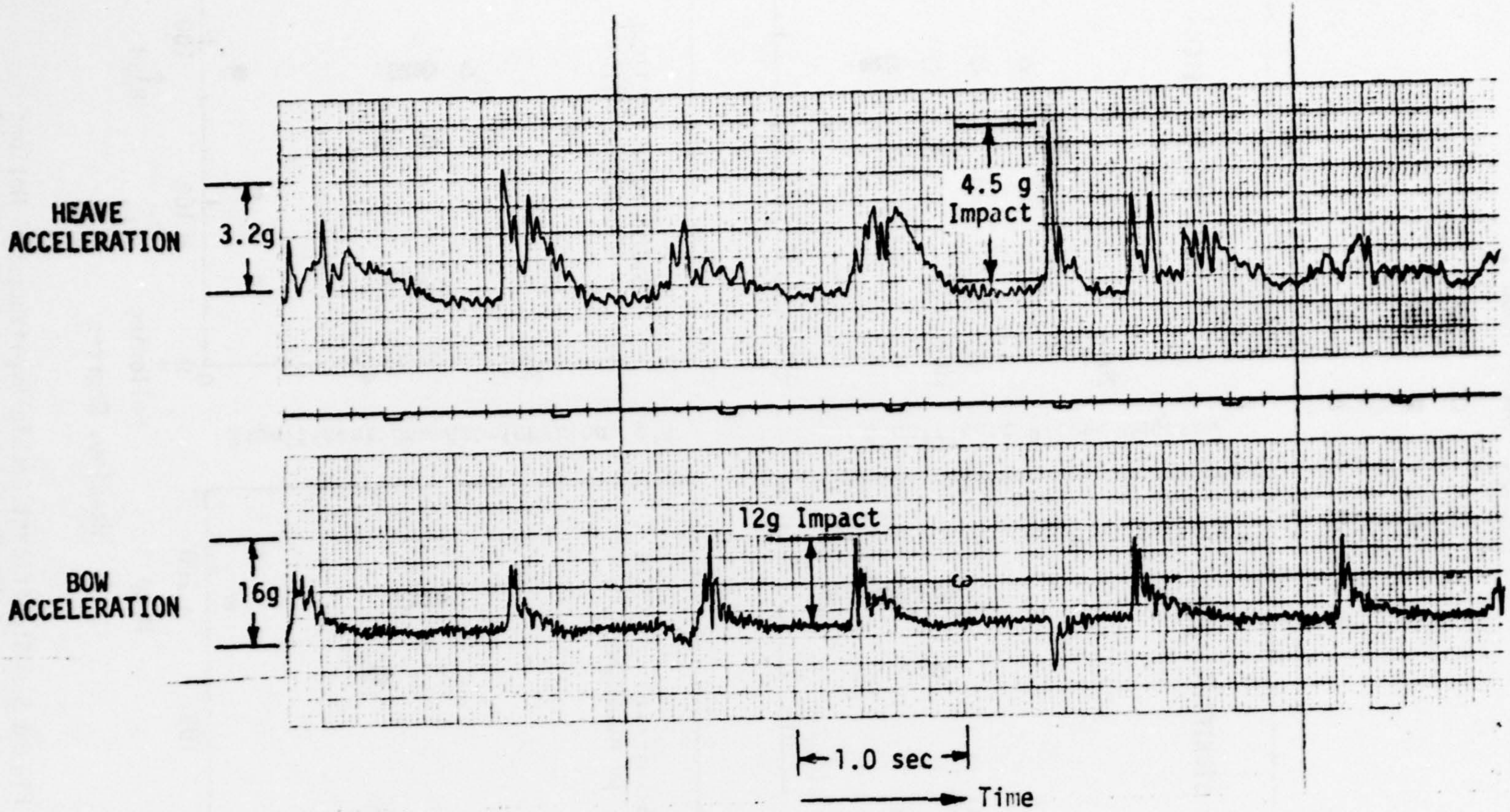

Figure 6a - Typical Time History for KAAMA in Head Seas at 60.8 knots

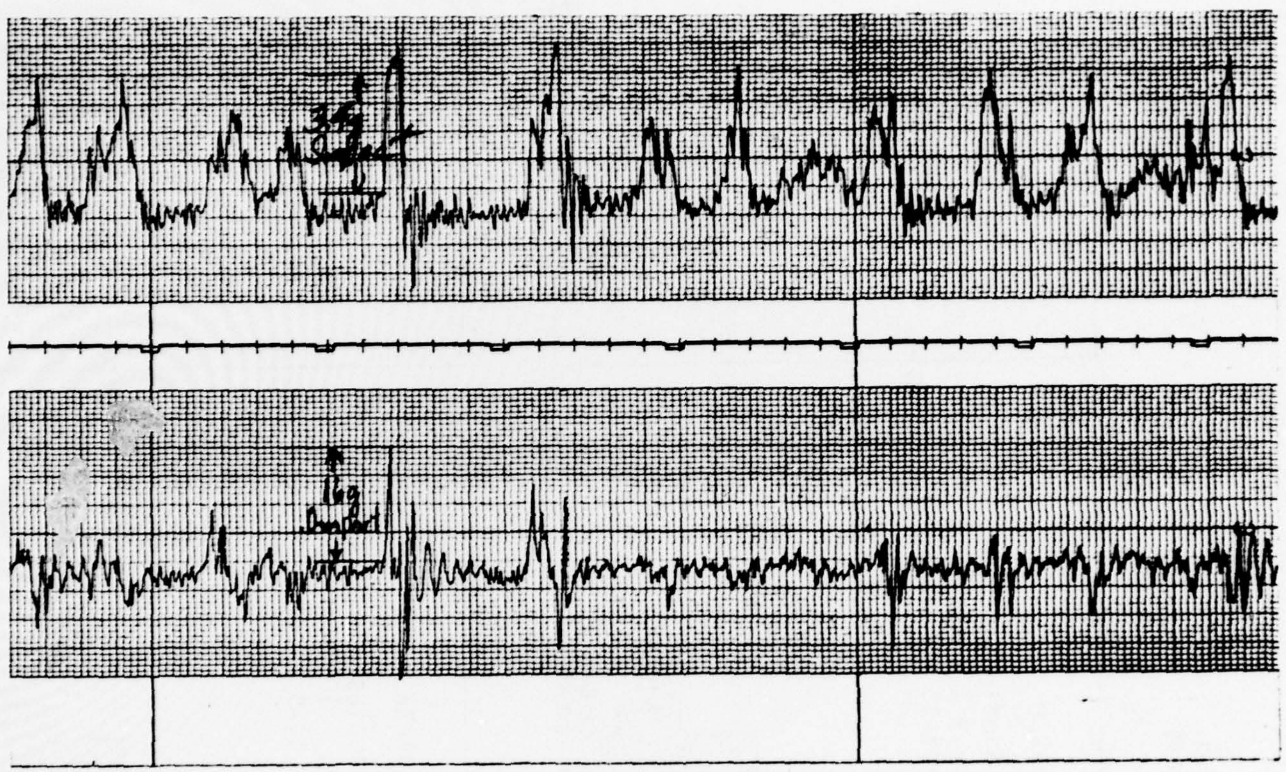

Figure 6b - Typical Acceleration Time History for KUDU in Head Seas at 60.8 knots

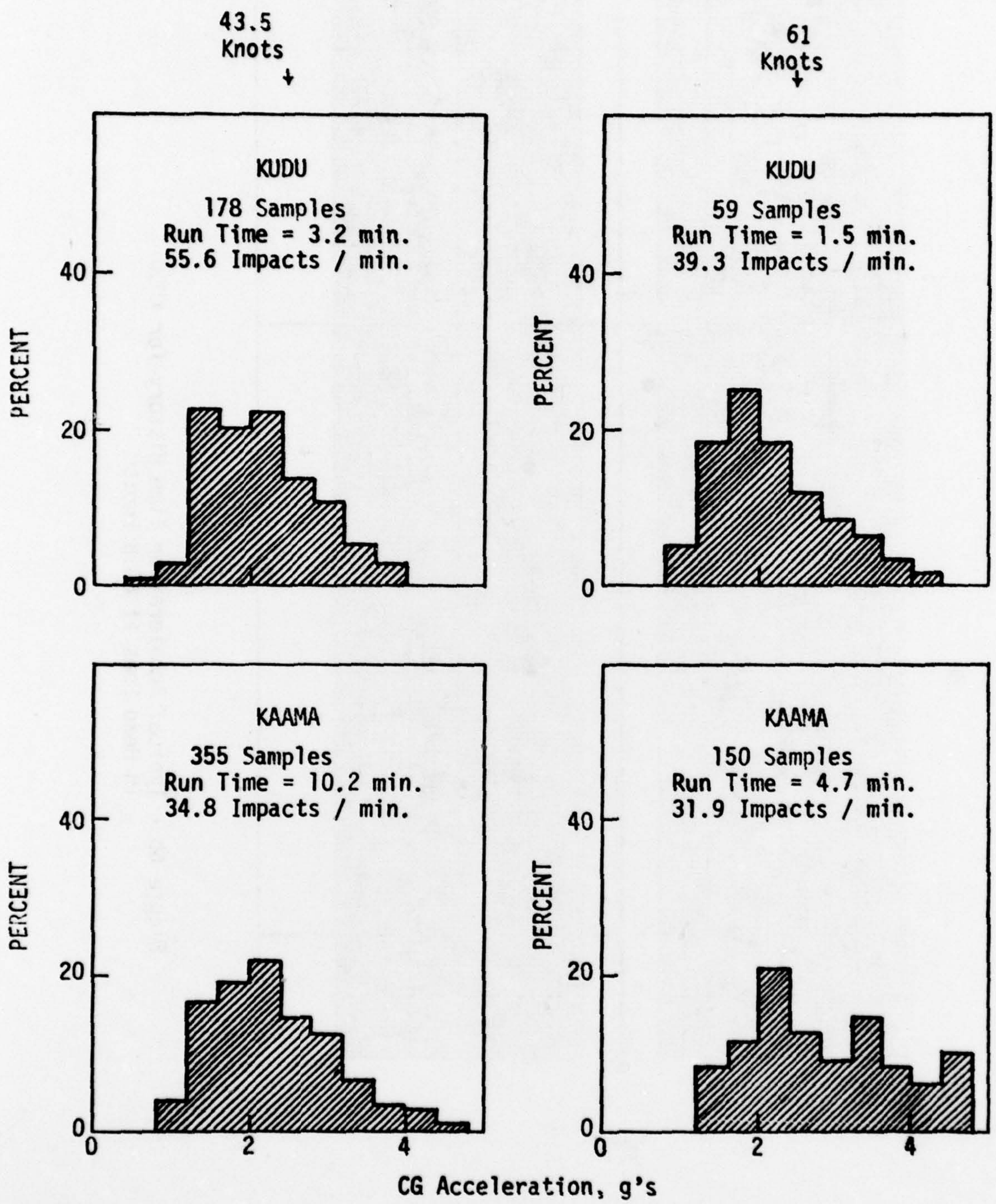

Figure 7 - Histograms of LCG Impact Accelerations

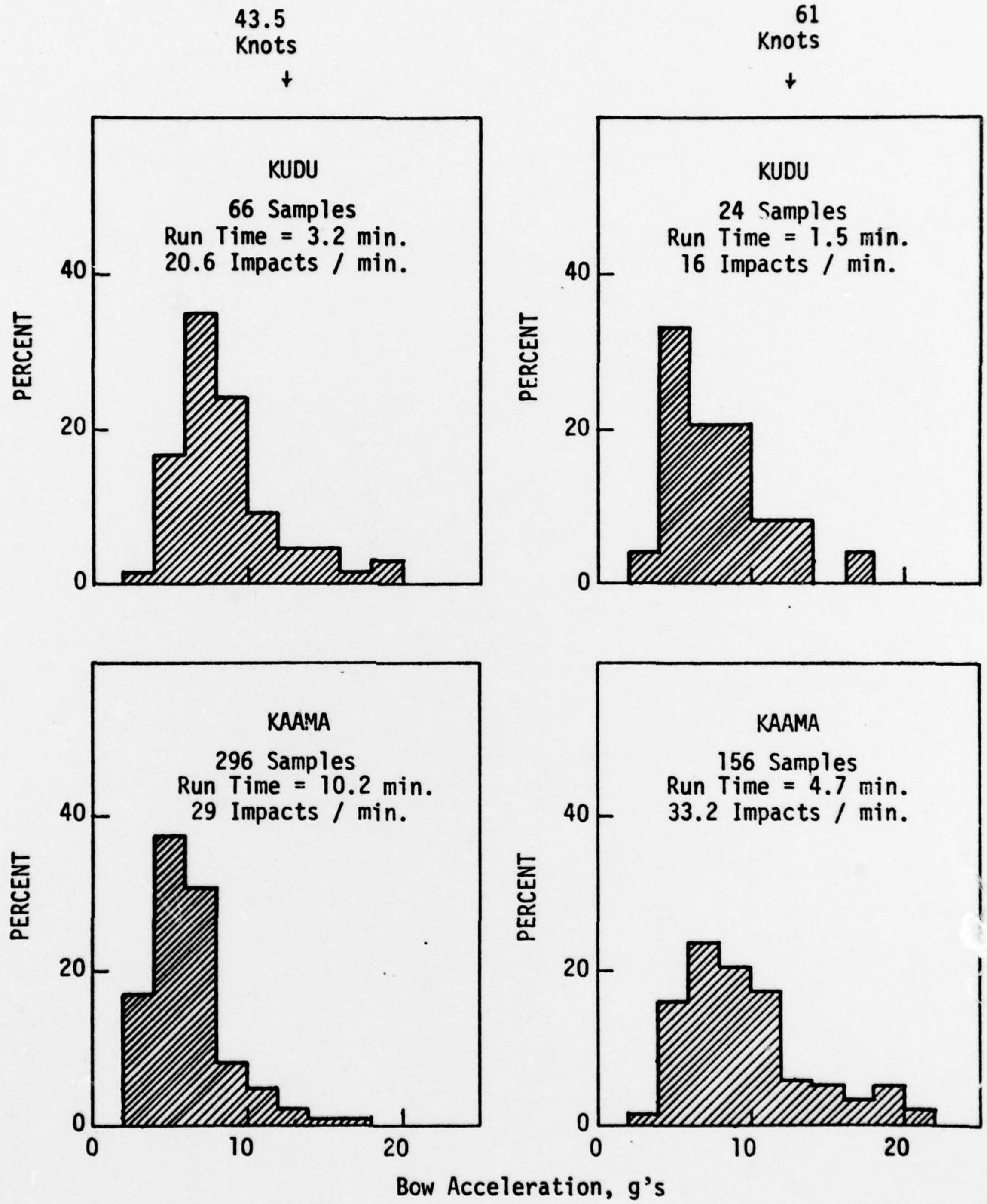

Figure 8 - Histograms of Bow Impact Accelerations

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