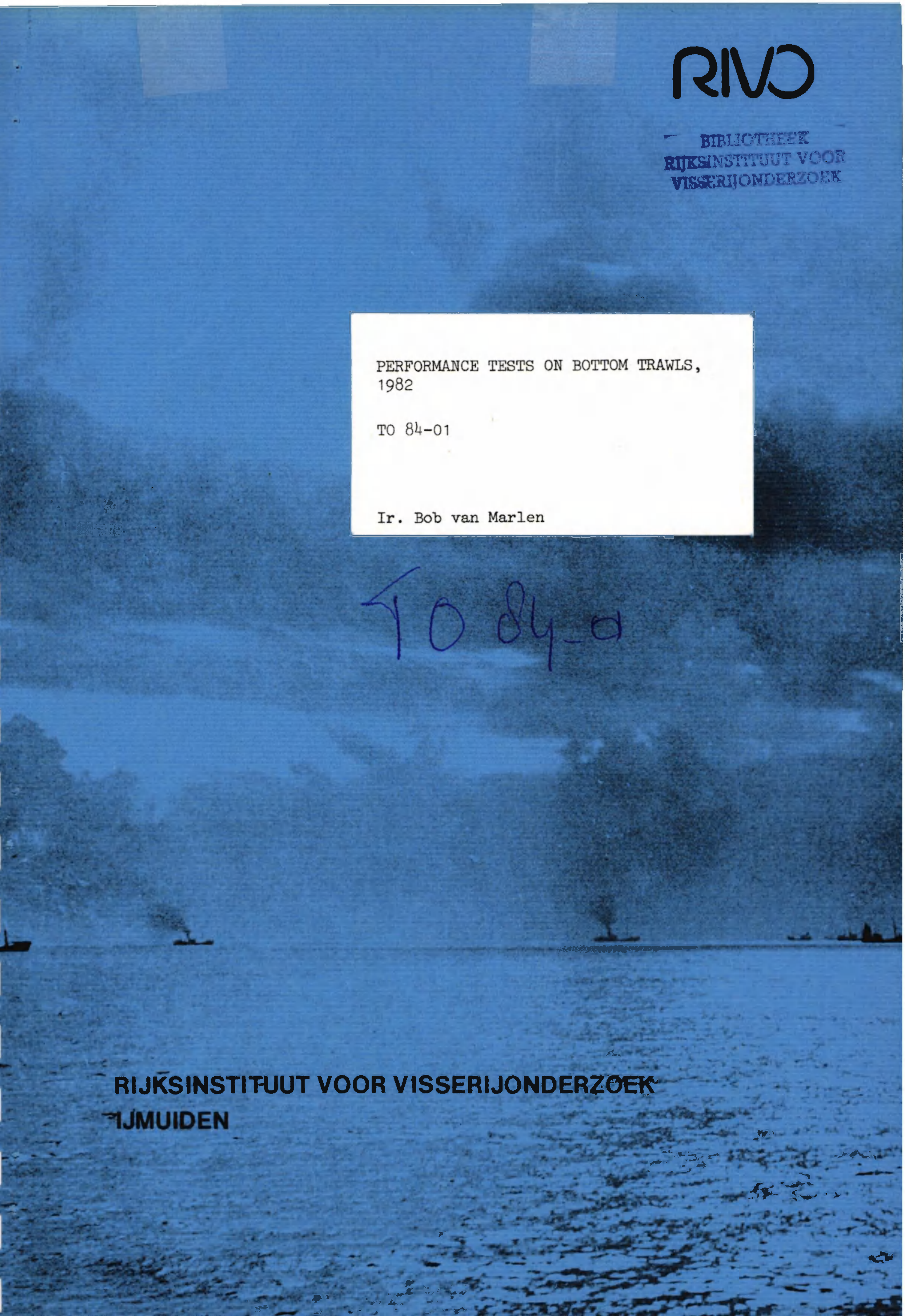

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PERFORMANCE TESTS ON BOTTOM TRAWLS, 1982

TO 84-01

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Finally I would like to thank Mr. Wilbert Blom for his assistance on the rig sketches and Mrs. Marja Bruisschaart for typing the manuscript.

B. van Marlen, M.Sc.

LIST OF FIGURES

Figure nrs. 7, 8, 11, 12 and 14 were omitted to save space; their contents did not contribute in an essential way to the ones included in the report.

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SUMMARY

In April 1982 model experiments have been done in the flume tank of S.F.I.A. at Hull prior to full scale tests on the FRV "Tridens" in August and October. Four nets have been tested, two so-called loggernets, one with 20 cm meshes in the square and one with 40 cm meshes, a bobbin trawl used for pair trawling and single boat trawling and a so-called "balloon-trawl" made by S.F.I.A. Parameters of the rigging have been varied throughout the experiments, such as warp length, door size and type, sweep and bridle lengths, number and position of floats and kites mounted on the headline. Table 1 and figure 2 summarise all these variations. The trials technique and the instrumentation used were very similar to those used in testing pelagic nets over the previous years. The analysis of data has been up-dated with a series of computer programmes in PASCAL, with the use of a PDP-11/44 mini computer, including data-input, regression analysis and plotting routines.
Different nets react in different ways to alterations of rigging parameters. A comparison of polyvalent with V-doors shows a better efficiency and spreading power with the poly-valents for one of the loggernets, but strangely enough not for the other one.
Changing door size with the same type of door lead to a decrease in horizontal openings with a smaller surface area as may be expected. Due to a rise in headline height the towing efficiency may increase substantially. It is therefore important to choose the right size of door for each net, which also depends on the warp to depth ratio and the fishing ground concerned.
Fuel savings are to be obtained with a proper door size.
A decrease of 2 m^2 of the surface area of a V-door may result in a saving of 100 hp on the propeller shaft.
Warp length should be adjusted to the depth in question in such a manner, that no more warp is payed out than strictly necessary not to lift the doors from the seabed. Paying out more can lead to an increase in horizontal openings of the net against a decrease in headline height. The outcome depends on the equilibrium of warp, lift forces and backstrop tensions on the doors.
With high opening trawls like net C an extension of the upper bridle will result in more headline height and a more distorted belly of the net. To catch certain species it may be worthwhile to do so.
In most cases in pays to have a lifting device on the headline of a trawl like floats or kites. Kites usually are more effective but the effect is mostly very local, as can be seen from model tests.
Floats do have an effect on the entire headline and may ease the shooting procedure of a net by keeping the headline afloat. The improved efficiency justifies the use of them in spite of the additional drag, which is very hard to distinguish from the rise in net drag.
Variations of angle of attack of the doors have been investigated for the balloon trawl and did not show significant differences.
Practical reasons such as spreading behaviour during the shooting process, and the formation of sand clouds by the boards seem to be of none importance to choose an attack angle of an otterboard.
There is a different general pattern of reaction of bottom trawls from midwater trawls.
At low speeds the boards usually tend to fall down with bottom trawls, resulting in a drastical spread reduction, whereas a midwater trawl simply sinks to a greater depth at such speeds.
At high speeds the board may come of the bottom when the warps are tight, but this has not been found at the speed in use with these nets. Midwater trawls usually rise when the towing speed is increased, up to a level where the doors are on the surface and the spread reduces. These physical boundaries are not taken care of when using lineair regression formulae, and it may be better to choose other gression lines.

An additional parameter to controle is the composition and depth of the seabed when testing bottom trawls.
Having instruments so close to the seabed may be risky, while midwater testing enables more degrees of freedom.
Comparison of 1/10 scale model and full scale measurements show discrepancies in gear dimensions and drag forces partially caused by different lengths of sweeps and bridles and partially by so-called scale effects, which arise from the fact that a full scale net can not be modelled mesh for mesh.
The loggernets are worse from this point of view while the bobbin trawl and the balloon trawl models show a better agreement with the full scale nets.
The use of models will be justified however to determine qualitive relationships and moreover to give a picture of the net shape at different riggings.

1. INTRODUCTION

In order to save energy in bottom trawl fishery one should know the resistance of all different parts of the fishing gear. Only then possible areas of improvement of the overall efficiency of a net can be given.
Prior to full scale tests at sea, scale models of four different bottom trawls were tested in the flume tank of the Sea Industry Authority (S.F.I.A.) at Hull, United Kingdom in April 1982.
These tests and the results compared to full scale measurements will be described in Chapter 4.
During 1982 two periods of full scale testing were chosen in August and October. The first experiments were done in the North Sea, the second took place in coastal waters of Portugal in order to avoid bad weather conditions. Apart from this the conditions of the seabed play an important role in the results of the experiments. Preferably the bottom should be flat and of the same composition at the depth range of interest. Obstacles on the seabed may cause damage to the gear or even the loss of it. A very detailed fishing map is as essential as a very accurate reading of the ships position.
The measuring equipment and techniques are described in Chapter 2, while results are given in Chapter 3 on gear geometry, drag forces and general performance indicators.

2. EQUIPMENT AND MEASURING TECHNIQUES

2.1. Gears

A sample of commonly used nets was chosen. The so-called "loggernet" is a fairly old type of net used by Dutch bottomtrawlers for flatfish and roundfish.
Net A is a standard "loggernet" and net B a slightly modified net with 400 mm meshsize in the square and wings, instead of the 200 mm of net A. The cutting rates are the same for both nets. The footrope measures 35 m and the headline 30.5 m (Figure: 1a,b).
The total twine area of net A is 45.255 m^2 and of net B 42.485 m^2.
The bigger meshes result in a decrease of 6%.
Pair trawling becomes more popular nowadays and a common type is net C given in figure 1c, derived from a Scottish design, with a headline of 38 m and a fishing line of 28 m in length, while having a total twine area of 84.713 m^2.
Net D is a "balloon trawl" designed by the Sea Fish Industry Authority (S.F.I.A.) of Hull, United Kingdom. It has been tested on a model scale in the flume tank of Hull and a full scale during the experiments in October 1982 on a cooperative research programme between RIVO and the SFIA (figure: 1d).
The headline is 100.5 ft (30.63 m) in length and the fishing line measures 85.5 ft (26.06 m), twine area 63.272 m^2.

2.2. Rigging

Several different trawl boards were used to determine the influence of board size on net geometry and gear drag.
Net A has been tested with 850 kg Polyvalent doors (2.90x1.75 m) and 830 kg V-doors (3.00x1.83 m).
Net B with both these two doors and in addition with smaller V-doors (2.44x1.42 m), weighing 450 kg in air.
Net C with the 830 kg V-doors only and finally net D with the small 450 kg

V-doors (2.44x1.42 m).
Table I summarises all the experiments with the variables in question. The rigging was varied on subsequent pairs of hauls.
The loggernets were fished with a single sweep and split bridle system and a split back strop arrangement.
The pair trawl was fished with a single sweep and a split bridle system. In one occasion the top bridle had been extended 0.9 m to determine the influence on the gear.
The balloon trawl has been tested with a thinner warp of 20 mm diameter, with two different arrangements of floatation attached to the headline. Sweeps of different lengths has been used to determine the influence on the gear. The bridle length was kept constant at 42 m and the extension in the lower bridle was kept at 6.5 m except for one case where 4.7 m has been used. The different rigs are depicted in figure 2 for the full scale and model experiments.
Floatation has been varied throughout the trials on the loggernets and in some cases a 60x80 cm flat wooden kite has been attached to the headline centre. For these nets sweep lengths were mainly kept on 100 m, while also lengths of 60 m were used.
In the experiments of August bridle lenghts of 40.0 m are used, while during October the lengths had been reduced to 39.0 m, due to repair works done on the split eyes.
There is also a difference in backstrop arrangement. At the first set of trials in August lengths of 4.5 m were used as double backstrop for the polyvalent doors and single ones for the V-doors.
Later on for net D it was decided to change over to a total of two strops attached to one another to ease the hauling procedure of the selfrecording load cells mounted just behind the backstrops.
For the bobbin trawl the amount of floats was kept at 22.0 plastic ones of 10 liter each, while no kites were used.
The surface areas of the doors are roughly:

Polyvalent 850	: 4.5 m^2
V-10	: 5.5 m^2
V-8	: 3.5 m^2

2.3. Trials technique

The trials technique has been quite similar to the one used in previous research on pelagic nets, which has been described thoroughly in references (4), (5) and (6).
There are some differences in testing bottom trawls however.
First of all the influence on the seabed conditions is of outmost importance. A sandy bottom will give different results from a muddy ground. One should take this into account when comparing results of different locations.
The second difference is that the depth of the gear is not determined by the towing speed as is the case when trawling in midwater. Adjustments to the depth are mainly done by paying out more warp. Therefore it is hard to compare results derived on different depths.
The third major difference is the greater vulnerability of instruments attached to a bottom trawl in positions close to the seabed.
For instance, load cells may easily hit a rock or bolder, whereas the presence of a sand cloud may cause trouble with some instruments. For this reason it became policy to place the instruments in positions as far from the seabed as possible, such as upper bridles instead of lower ones, or just behind the backstrops.

A fourth difference is, that the time interval for a bottom trawl to settle itself when changing the speed is very much shorter (mostly in the range of 5 minutes) than with midwater trawls that will reach an equilibrium in about 20 minutes.
In fact this means, that hauls of 5 blocks each will be shorter, due to a smaller loss of time between the measurements, and more hauls can be made on one day, at maximum 6.
Bottom trawl experiments are usually done on fishing grounds with a restricted water depth.
The influence of tidal currents may be large at such positions, and therefore reciprocal courses were taken, forming haul pairs of two sets of experiments related to each other.
Common variables of the rigging are:
- warplength related to depth, and warp diameter;
- otterboards, size, type and angle of attack;
- backstrop length and arrangement;
- sweep length;
- bridle lengths with possible extensions;
- number, position and size of floats;
- number, position and size of kites.

Table 1 gives a summary of all experiments done during 1982.

2.4. Instrumentation

The set of instruments used on "Tridens" has been described on various occasions in (4), (5) and (6).
In most cases the upper wing-end spread was measured with a cableless FURUNO transmitter and transponder system, the headline height by an echosounder on the headline. No other net dimensions have been recorded.
Net drag was usually measured by selfrecording load cells placed behind the backstrops or in the upper bridle close to the wing-ends.
Gear drag was recorded by deck load cells with information on warp length, door spread and door depth.
The shaft horsepower has been measured by two transducers mounted on the propeller shaft, approximately 1.0 m apart by relating the time interval shift recorded to the torsion angle of the shaft, which determines the torque on the shaft.
Towing speed was measured with the ships Doppler log as speed over the ground and with time interval/distance travelled recordings.
Door spread has been measured by transducers mounted on the Port door attached to the ship with a separate cable. In most cases the door depth could be picked up with the same transducer. In some cases two transducers were used with a switch unit between them.

2.5. Data analysis

The analysis technique has been improved, although some "manual steps" are still incorporated in the process.
Recordings usually are written on recorder paper, reread after the cruise and written on tabulation sheets.
A series of computer programmes has been written to ease the data processing. The language used is "PASCAL", the system on which programmes were run is a PDP/11-44 by Digital Equipment.
The first step is to type in all data from the tabulation sheets using an input programme. A distinction has been made between several types of data, in order to avoid unnecessary input. Some information will be constant over the full range of experiments, such as data about a research vessel, assumed that the same boat has been used throughout. Other data can vary per group of haul pairs such as door

weights and dimensions and the position of transducers fixed on the doors.
Dimensions of the rigging may vary for each haul pair, consisting of two hauls on reciprocal courses.
Data on the environmental conditions of the experiments such as ships position, wind speed and -direction and ships course will be different for each haul.
The structure of the PASCAL-language allows a built-up of records of data, which suits this description.
Measurements are put in as so-called block values for each haul, where a block is defined as the interval for which parameters are recorded.
After the manual input the values have to be checked on typing errors.
Missing values are typed in as zero's.
There are a few standard cases of data missing of which the way to handle varies:

1. Only a few values are missing out of a sequence.
   Usually the treatment is to draw a curve or regression line against speed and to calculate or to determine graphically the missing values at the speeds in question.
2. A whole range is missing for one of both haul pairs.
   In this case the data of the second haul will enable an estimation of the missing values from the plotted curve of the regression line through the values this haul.
3. Data is missing for both hauls of a haul pair.
   One way to overcome this problem is to use the data of related experiments, another way is to derive them from available data on a parameter which is connected to the missing one. For instance a relationship holds between door- and wing-end spread of a net.
   This has in fact been done on a number of occasions.

It will be clear that the results become more dubious as more data is missing and there is a limit to this procedure where results cannot bear the name of "scientifically obtained" data.
One should take care not to pass this limit. Sometimes it is wiser to quote data simply as missing!
By plotting two speed readings against each other it was easy to determine false inputs and misreadings.
After all data have been put in and stored on data-files and all corrections havetaken place, one can apply calibration formulae to the values.
For instance load cells usually show a calibration curve varying over a range of experiments.
It is also possible to make the calibration correction first before determining missing values.
The speed correction for tide has been determined by plotting the sum of warp tensions against speed for both hauls. The value has been taken in the middle of the speed range as both regression lines are generally not parallel. Half of this speed difference has been added to the values for one haul and substracted from the values of the second one, thus shifting the lines towards each other. A variation of tidal speed in time has not been regarded.
With this corrected speed all sorts of derived quantities are calculated, such as the shape of the warps and the loads at the end where measurements were not taken (in front of the doors), or the components of warp and bridle tension in the direction of motion and two other directions perpendicular to this one. Summation of these components will result in the values for gear and net drag.

Data to be plotted is stored on a new file consisting of measured values and values derived by calculation by merging existing files.
With the aid of plot and regression routines the figures needed for the report are drawn on a Hewlett-Packard plotter.
These graphs are checked on irregularities and outlaying points, that sometimes require an additional check on the data and a possible correction after which the process described above will have to be repeated.
In an iterative manner one will get to a set of final data and final graphs to use in the report.
Although a visual check on data is probably always necessary, the slow process of recording data from traces and typing them in into a computer can be speed-up by digitising the measurements and temporarely storing data on board of a research vessel on for instance a floppy disc.
In the geometry calculations some assumptions have been used regarding the orientation angles of the otterboards as they were not measured.
From reference (2) it was found that for a polyvalent door with a weight of 1200 kg

angle of attack $\alpha = 50^{\circ}$
angle of heel $\theta = 29.6^{\circ}$ at 3 knots speed
$\theta = 1.8^{\circ}$ at 4 knots speed.

From this data it was decided to take

$\theta = -28 * (V \text{ in knots}) + 114$ degrees

and

$\alpha = 18$ degrees + α (sweeps) for polyvalent doors
$\alpha = 27$ degrees + α (sweeps) for a V-door.

These formulae have been used in the computer analysis.

3. DISCUSSION OF RESULTS

3.1. General

Table 2 to 5 summarise the lineair regression results for towing speeds 3, 4 and 5 knots of all relevant geometry and performance parameters.

3.2. Effect of buoyancy and lifting devices on net A

The influence of adding floatation or kites to this net can be found from the comparison of haul pairs 1, 2 and 3.
A very sensitive parameter is the headline height, which turned out to be largest for the case with floats and a kite attached to the headline, as may be expected. Compared to the lowest value the height did increase 1.61 m at 4.0 knots towing speed.
Smallest values are found with the 12 10 liter floats only.
Door spread and wing-end spread are related to each other.
At 4.0 knots speed the omission of 10 floats caused the door spread to increase approximately 8.0 meters and the wing-end spread approximately 4.0 meters.
Adding a 60x80 cm kite to the 12 floats mounted on the headline does not seem to influence the spreads significantly at 4.0 knots, but at lower speeds the doors of the net with floats and kite do have a tendency to fall down, resulting in a drastic decrease in spread values. In fact this causes the regression line to have a positive slope, which does not represent the phenomena at speeds over 4.0 knots.
Due to the differences in headline height the mouth area of the three cases differ greatly with maximum values for the net with floats and a kite.
The sweep divergence determines with the towing speed the catchability of a trawl.
At 4.0 knots all the values are quite similar being approximately 20°. The slope of the curves is more dependent on the rigging. For a net with a kite attached to the headline the divergence decreases less with higher speeds. The regression lines, though describing the true phenomena of a sharp decrease in spread at low speeds are not representative for the values at speeds higher than 4.0 knots. A different regression than a lineair one is needed for such cases.
Generally a bigger mouth area means a higher value of the net drag and this is also the case for these experiments. A difference of 1.25 tonnes is quite feasible for these nets. The net drag seems to be invariant for floatation or a kite, a maximum difference of only 0.4 tonnes is found at high speeds.
The highest values of the swept volume index are found for the case of the floats and the kite attached in spite of the higher drag values. If the objective is to sift the greatest amount of water with the smallest resistance it pays to use the floats and kite together, although the differences are rather small.
Finally, and from the fishermans point of view more important, the addition of a kite to a trawl with floats on the headline causes an increase of some 100 hp of the shaft horsepower needed, at a speed of 4.0 knots. Changing over from 12 floats of 10 liter volume to 3 floats and a kite of 60x80 cm will cause an increase of 45 hp on the shaft.

It should be kept in mind that these values apply to a certain type of vessel and certain sea conditions, but they can serve as a rough guideline.

3.3. The effect of sweep length and lifting devices on net A

Haul pairs 10, 11 and 12 are experiments with the same net A on a different ground at a different time.
Variables of the rigging are given in Tabel 1.
Due to a very rapidly changing depth in the area and the presence of artisanal fishing gear it was practically impossible to keep the depth at a constant value.
More warp had to be paid out on deeper waters resulting in measurements, that are only partially comparable.
Adding 40 m of sweep causes the door spread to increase some 8.0 m and the wing-end spread about 1.0 m at all speeds.
Changing floats into a kite leads to a small increase in spread values with increasing speed, but the height is more drastically influenced with an increase of approximately 0.50 m.
The sweep length does show a strong influence on the headline height.
With sweeps of 60 m the height turnes out to be 1.55 m higher.
The mouth area shows a tremendous amount of scatter for these hauls, with the highest average values for the net with 60 m sweeps.
With the 100 m sweeps the kite seems to open the trawl more than the floats.
The sweep divergence is bigger for shorter sweeps, as may be expected.
40 Meter shorter sweeps caused the divergence to decrease 5^{o}.
The floats or the kite do not seem to influence the sweep divergence to a great extend when the sweep length is kept constant.
The gear drag of the net with 60 m sweeps turns out to be 0.8 ton higher than for the same net with 100 m sweeps in spite of the additional drag of the longer sweeps when fishing at a speed of 4.0 knots.
The kite leads to an increase of 0.4 tonnes in gear drag compared to the floats.
The net drag of these riggings is very much alike irrespective of speed.
The best performance is found with the 60 m sweeps, leading to an increase of some 30% compared to 100 m sweep length.
The kite seems to be preferable over the floats only, leading to an increase in swept volume index of approximately 10%.
In spite of the better towing efficiency of the net with short sweeps, the shaft horsepower needed is some 60 hp higher at a speed of 4.0 knots, as may be expected from the rise in gear drag.
There is very little difference in required power between the floats and the kite.

3.4. The influence of the type of otterboard on net A

The influence of the type and dimensions of otterboards can be determined from comparison of haul pairs 1 to 11 and 3 to 12 (Table 1).
The doorspread with the polyvalent doors turned out to be approximately 23 m greater than with V-doors, indicating the better spreading power of this type, resulting in greater wing-end spread values, and smaller headline height values.
The mouth area is slightly bigger with the polyvalent doors due to the higher wing-end spread values. The headline height decreased with polyvalent doors as may be expected.

Sweep divergence is connected to door and wing-end spread and consequently the divergence is greater with polyvalent doors.
The net drag values are very much alike at speeds of 4.0 knots, but the gear drag turned out to be higher with the V-doors, on average 1.5 tonnes.
The swept volume index increased considerably when changing from V-doors to polyvalent doors, especially at lower speeds. At 4.0 knots the increase is on average 30%.
The shaft horsepower turns out to be higher for the polyvalent doors, which seems to be contradictory to the fact that the gear drag was lower.
A possible explanation may be the difference in weather condition during both experiments. The hauls with polyvalent doors were made in rougher sea conditions causing stronger ship motions resulting in additional ship resistance.

3.5. Effect of door type and lifting devices on net B

The effect of the type of door on net B can be determined by comparing haul pairs 4 and 6 (Table 1), where all other parameters are kept the same.
In this case we find bigger door spread values for the V-door, contradictory to the results for net A.
The differences in wing-end spread and headline height are negligible.
Haul pair 6 show a great amount of scatter in door spread and headline readings.
The omission of 12 floats of 10 liter does change the doorspread values considerably. The headline height value drops approximately 1.0 m at 4.0 knots.
The mouth area decreases slightly when changing polyvalent into V-doors, but drastically when the floats are taken off.
The values of the sweep divergence are very much alike, with the highest ones for the net with the kite only and the V-doors.
A comparison of gear and net drags learns, that the V-door has a higher drag value. While the net drag turned out to be smaller with the V-doors, the gear drag showed higher values, which can only be caused by the drag of the doors.
The presence of the floats accounts for a difference in net and gear drag compared with the net with a kite only, that rises with increasing speed.
At 5.0 knots the floats lead to an additional drag of approximately 1.0 tonne.
The gear drag is also influenced. At speeds less than 4.0 knots the drag is less and at higher speeds the total drag increases with some 2.0 tonnes due to the floats.
The differences in swept volume index between the polyvalent and the V-doors are very small.
The floats are lifting the regression line up especially at low speeds, due to the greater mouth area in spite of the added resistance.
At speeds over 4.5 knots these differences diminish.
The amount of horsepower needed to tow the gear is greater for the V-door, due to greater values of the gear drag. With floats the power to tow the gear is higher for speeds over 3.5 knots.
The door and wing-end spread of net B will alter when replacing 12 floats of 10 liter each with 2 of these floats on the wing-ends and a 60x80 cm kite with 1 float attached to it (haul pairs 14 and 16).
The kite rises the headline centre, resulting in a loss in spread and an increase in mouth area at low speeds. Due to scatter in the results for haul pair 16 the picture is not very clear.

The sweep divergence decreases faster with speed with the kite, at 3.0 knots the values are equal.
The gear and net drag for both cases are quite similar, which could be expected looking at the mouth areas.
When looking at the towing efficiency the kite seems to be better of at low speeds. The swept volume index is 8% higher at 4.0 knots in this case.
As the gear powers are almost equal the differences in shaft horsepower must be due to the seastate.
Indeed for haul pair 14 the windforce was Bf.4 and for 16 a value of Bf.2 had been recorded, resulting in an increase of almost 100 hp.

3.6. The influence of the dimensions of a V-door on net B

Replacing 10 ft V-doors with 8 ft V-doors influences the values of doorspread to a great amount, which of course may be expected bearing in mind that the surface of these smaller doors is only 57% of the big ones.
At 4.0 knots the V-8 doors will give approximately 33 meter less spread, a percentage difference of 42%. This should effect the other gear dimensions.
The headline height increases considerably, over 1.0 meters at 5.0 knots. The mouth areas are quite similar at a speed of 4.0 knots, whereas at higher speeds the smaller doors gave the highest values.
The sweep divergence is bigger for the V-10 door, a difference of 8.6 degreees at 4.0 knots.
The net drag is very similar for both nets, but the V-10 door causes the gear drag to be higher.
At 4.0 knots the difference equals 1.5 tonnes and at 5.0 knots 2.0 tonnes.
It is therefore essential to match doors and net.
This is very clearly illustrated by looking at the swept volume indices. With this criterion the smaller doors show a distinct superiority, especially in the high range of speeds, where an increase of 60% in efficiency can be gained.
The gear and shaft horsepowers are substantially smaller for the V-8 door. A decrease of 100 hp can be reached with this door at speeds over 4.0 knots.
It is easy to save energy when chosing smaller doors. The only boundary condition will be given by the sweep angles which are described by the size and species of fish to be caught, in connection with the towing speed.

3.7. Effect of warp length on net B

A comparison of haul pairs 15 and 17 enables to determine the effect of paying out 150 m of extra warp for net B, with all other rigging parameters kept constant.
The door spread values do not show a significant difference, as may be expected. Apparently the spreading power of these V-10 doors does not overcome the additional warp drag.
The headline height does increase with the longer warps, which normally indicates a reduction in wing-end spread. This does not occur in this case. The increase is about 1.0 meter. The picture is not very clear due to the great amount of scatter in the results.
Due to the greater height values the mouth area is bigger with 500 meters of warp.

As spreads are very similar the sweep angles also are.
The net drag of both cases do not differ to a great extend, but the gear drag values are slightly higher with the longer warps, which account for the additional warp drag.
In spite of this the towing efficiency expressed with the swept volume index turns out to be better with the 500 meter warps, caused by the bigger increase in mouth area.
The gear powers are slightly higher with the long warps but the shaft horsepower does not show any significant difference.

3.8. The influence of sweep length on net B

Haul pairs 6 and 16 are fished on different depths which does not allow a strictly sound comparison. But as the warp length is kept the same some conclusions can be made about an increase of sweep length of 40 meters.
The door spread values increase with almost 20.0 meters with the longer sweeps and the headline height decreases some 0.80 m at 4.0 knots.
The mouth areas for both cases are quite the same with a lot of scatter. The regression lines are doubtful for this reason.
More door spread means greater values of sweep divergence. At 4.0 knots the increase is some 4.5 degrees with the longer sweeps.
The net drag values compare very well for both cases, but the gear drag is higher for the long sweeps over the full range of speeds.
The difference amounts 0.30-0.40 tonnes.
The swept volume indices are almost equal, especially with speeds around 4.0 knots.
The gear powers of both nets are also similar, whereas the differences in shaft power are substantial, 130 hp at 4.0 knots, probably caused by the rough seastate of haul pair 6 compared to 16.

3.9. A comparison in performance between nets A and B, fished with the same rigging

A comparison of nets A and B under equal circumstances can be made from haul pairs 3 and 4.
The door spread values are almost equal with the same tendency for the doors to fall down at low speeds.
The headline height is bigger for net A. At 4.0 knots an increase of 0.35 cm has been recorded. Net A shows a bigger mouth area for all speeds.
The sweep divergence is equal for both nets as is the case for the gear and net drag.
Apparently the bigger meshes of the square of net B do not lead to a decrease in drag.
Due to the bigger mouth area the swept volume index of net A is substantially larger. At 4.0 knots the difference amounts 30%.
The values for the gear horsepowers are equal as may be expected from the gear drag values.
Consequently with a smaller towing efficiency and the same resistance the choice of increasing mesh size in the square does not seem to be justified.
The twine area of the 20 cm mesh panels in the square of net A (i.e. 7.954 m^2) is 46% larger than that of the same panels of net B (i.e. 5.460 m^2), but the difference in total twine area of both nets (45.255 m^2 for net A and 42.485 m^2 for net B) accounts only 6.5%, apparently too small of a difference to give a noticable drag reduction.

3.10. The effect of extending the upper bridle with 0.9 m on net C

Due to the fact that this gear was completely lost during the experiments of October 1982 only a limited amount of hauls have been made with net C. The effect of an extension of 0.90 m to the upper bridle of 40 meters in length can be read from the results of haul pairs 7 and 8.
The door spread values are slightly bigger with the extension, but more significant is the increase in headline height of 1.0 meter at 4.0 knots. This leads to a substantially larger mouth area for the net with extension.
The sweep divergence of both cases is very much alike as is the case with the net drag. The gear drag is smaller for the net with extension, contradictory to the fact that the mouth area is bigger in this case.
The swept volume values are larger for the net with extension, due to the bigger mouth area.
At 4.0 knots the difference is 42%.
The gear power is slightly larger for the net without extension and the same applies to the shaft horsepower.

3.11. The influence of the warplength on net C

The effect of a variation in warp length has been investigated in haul pairs 8 and 9, where a difference of 200 m of warp has been chosen.
Of course the door spread increases when paying out more warp.
The increase from 300 meters to 500 meters causes the spread to increase with 14.5 meters at 4.0 knots towing speed and 19.7 meters at 5.0 knots.
The smaller spread values enable the gear to open more in the vertical direction for speeds less than 4.5 knots.
At 3.0 knots the headline height turns out to be 1.43 meters higher when fishing with the short warps.
The wing-end areas are quite the same at a speed of 4.0 knots and bigger at lower speeds for the 300 meter warps.
The sweep divergence is smaller for short warps at speeds over 3.0 knots.
At 5.0 knots the difference is 3 degrees.
A comparison of gear and net drag values learns the gear drag to be approximately 0.5 tonnes higher, but the net drag value is less, which cannot be explained from the mouth area values.
It should be remarked that the scatter in the data of haul pair 9 casts doubt on the actual position of the regression line.
The towing efficiency is considerably better for short warps, although the advantage decreases rapidly with speed. At 4.0 knots both rigs show equal results.
Gear powers are very similar, but the shaft power required seems to be higher for 500 meter warps on average 50 hp, which cannot follow from difference in seastate as they were equal.
There are few data on the performance of net C with the shorter sweeps of 100.9 m to upper wing-ends and 100.0 m to the lower wing-ends.
Door spread values are of the same order of magnitude, as is the case for the headline height.
The same applies to the mouth area, but the sweep divergence is substantially larger, almost 6 degrees at 4.0 knots speed.
The gear and net drags are the lowest found with this gear, especially in the low speed range.
For speeds over 4.0 knots the swept volume index showed to be at its peak with this rig and the shaft and gear horsepowers are considerably less than with the sweep system of 140 meters in length.

For the shaft power a difference of 200 hp at 5.0 knots has been found, in quite similar weather conditions.
It is not clear why the gear drag is lower than with the other rigs, with the mouth area in this case being so much the same.

3.12. The effect of sweep length on net D with 40 floats on the headline

Parameters varied during the experiments with net D are the sweep length, the amount and position of floats on the headline and the warp and backstrop attachment points on the otterboards.
The depth and the type and size of otterboards were kept constant.
By comparing haul pairs 18, 19 and 20 the influence of the sweep length can be determined, although the alteration of warp attachment to the doors between haul pairs 19 and 20 contradicts with the requirement of keeping all other parameters at constant values when changing one.
The door spread diminishes when shortening the sweeps from 56.86 meter (30 fms + 2 m) to 38.58 m (20 fms + 2 m) and finally to 20.29 m (10 fms + 2 m), as may be expected. At 4.0 knots the decrease is 7.0 m for the first step and 3.8 m for the second one, so the effect is stronger when changing the longest sweep into shorter ones, possibly caused by the different attack angle.
Usually as door- and wing-end spread diminish the headline rises, but this net seems to react in a different manner. The highest headline heights are found with the largest spread values, a difference of more than 2.0 meters at 4.0 knots compared to the shortest sweeps.
The mouth areas being the product of the height and spread follow the same pattern as the headline height.
It should be noted, that the wing-end spread has only be recorded in a few cases and most values are derived by calculation.
Therefore the mouth area results are rather dubious.
The sweep divergence increases when shortening the length, especially for the shortest sweeps.
The effect on the net drag and the gear drag is not noticable, although the regression lines suggest a distinct variation at higher speeds due to their difference in slope.
Swept volume indices show maximum values for the long sweeps, due to the bigger mouth area. At higher speeds the differences decrease, at 3.0 knots they are 30% for each step down in length.
Regarding the gear and shaft horsepowers the differences found are negligible for the gear power and also for the shaft power at speeds over 4.0 knots.

3.13. The effect of angle of attack of the otterboards on net D

The influence of warp attachment on the performance of this net can be read of the results of haul pairs 20 and 21, with the V-door at its maximum angle of attack for haul pair 21.
Differences in door spread as given by the regression values are not very realistic, as for haul pair 21 the door seems to fall down at low speeds, resulting in a very low value of the door spread.
The spread at 4.0 knots is a good average and shows little difference.
The headline height is also quite the same for both rigs, with a lot of scatter for haul pair 21.
The mouth area is slightly bigger for the rig with the smallest attack angle of the doors, but the difference is not significant and unclear because of the great amount of scatter.
The sweep divergence regression lines show the same difference in

slope as the door spread lines, which is not representative for the measurements. In fact there is hardly any difference at all.
The gear and net drag values are identical for both haul pairs and the same applies to the swept volume indices.
Finally the gear powers are the same, but there are distinct differences in shaft horsepower. The values for haul pair 21 are dubious when compared to the other hauls.

3.14. The influence of sweep length with 54 floats on the headline on net D

The influence of sweep length with more floatation can be determined from a comparison of haul pairs 22, 23 and 24.
Door and wing-end spreads increases with sweep length and the increase is more significant when changing sweeps of 20.29 m into ones of 38.38 m.
The regression line of haul pair 23 showes definitely a distorted picture due to the doors to fall at low speeds.
Values over 3.5 knots are overestimated.
The maximum difference is about 10 m between the shortest and longest sweeps. Maximum values of headline height occur with the shortest sweeps. There is little difference between 38.38 m and 56.86 m with a tendency of the middle length to result in higher values at speeds less than 4.0 knots. Mouth areas turn out to be largest for the shortest sweeps, while the picture for the other two sweep lengths is similar to that of the headline height. The longest sweep results in bigger values than the middle one.
The sweep divergence curves follow a regular pattern with all curves having a maximum value at approximately 3.5 knots towing speed.
The regression lines are not representative at all, especially the one for haul pair 23. At low speeds the otterboards fall down resulting in a sharp decrease in spread and therefore in sweep angle also.
No significant distinction can be made for the gear and net drag of all three bridle lengths.
The swept volume index is largest for the shortest sweeps due to the rise in headline height with this rig.
The other two lengths show very similar results.
This may lead to the conclusion that short sweeps will fish more efficient, but this does not hold as sweeps do herd fish towards the net mouth and the area covered with long sweeps will be greater.
In fact the value of the door spread and the sweep divergence determine with the towing speed the catchability of a bottomtrawl to a great extend.
The power needed to tow the gear is very much the same for all bridle lengths. Differences in shaft horsepower are considerable at low speeds.
The weather conditions were ideal at the time and cannot be the cause of discrepancies.

3.15. The influence of the amount of floatation on net D, with different sweep lengths

The influence of adding 14 floats of 10 liter each to the 40 2 liter floats already in use can be found from haul pairs 21 and 22 at a sweep length of 20.29 m, from haul pairs 19 and 24 for the middle length of 38.38 m and from haul pairs 18 and 23 for the longest sweeps of 56.86 m, although in the latter two cases the warp and backstrop attachment points on the V-door were altered as well.
With the shortest sweeps the influence on the door spread turns out to be rather small.The addition of the floats causes a reduction of some 4.0 meters in door spread. The regression values are only representative at a speed of 4.0 knots.

The same applies to the two longer sweeps. In these cases the alteration in the angle of attack of the doors may emphasize the effect. More floatation means less spread, especially at low speeds.
The effect on the headline height is very significant.
For haul pairs 21 and 22 the headline rises 1.5 m with more floatation. For haul pairs 18 and 23 a rise in headline height is only noticable at speeds lower than 3.0 knots, whereas the height seems to fall down more quickly with increasing speed. For haul pairs 19 and 24 the headline height is larger with floats for speeds up to 4.5 knots. The decline with speed is also sharper.
The mouth area increases substantially when adding floatation both for the two shorter sweeps, although the effect is more pronounced with the shortest sweeps.
For haul pairs 18 and 23 a decrease in mouth area was found with the extra floatation added.
The sweep divergence decreases with more floats due to the reduction in door spread. The differences given by the regression lines are not realistic. A difference of 1.5 degree at 4.0 knots was found for haul pairs 21 and 22.The same remarks apply to the other haul pairs 18 and 23, whereas the values for haul pairs 19 and 24 are very similar with a tendency to drop faster at low speeds when the extra floats are added.
The added floats do lead to slightly bigger values of gear and net drag for the shortest sweeps, i.e. 0.24 tonnes at 4.0 knots and 0.42 tonnes at 5.0 knots for the gear drag, but for the longest sweeps the net drag differences are much greater, i.e. 0.82 tonnes at 4.0 knots and 1.40 tonnes at 5.0 knots.
For haul pairs 19 and 24 the gear drag values do not seem to be affected, but the net drag increases slightly, 0.29 tonnes at 4.0 knots and 0.48 tonnes at 5.0 knots.
It is hard to determine the resistance of the floats themselves from these figures. The floats will alter the mouth area of the trawl and this effect will also be measured at the same time.
Although the mouth area decreases with the longest sweeps, the net drag difference is greatest, which may partly be caused by the smaller sweep angles for this rig. The net drag consists of the sum of the components of the bridle forces in the direction of motion.
The added floatation causes an increase in the swept volume index for haul pairs 21, 22 and 19, 24, but a decrease for haul pairs 18 and 23, due to the decline in mouth area.
The improvement of efficiency seems to be more noticable at shorter sweep lengths.
The gear powers are not noticably effected by the added floats with all sweeplengths.
From these results no final conclusions can be made for the amount of floatation needed on this net. The only certainty is the rise in headline height due to the extra floats, and this will effect the catchability of the net.

4. MODEL EXPERIMENTS IN A FLUME TANK

4.1. General

During April 1982 scale models of nets A, B, C and D have been tested in the Flume Tank of the Sea Fish Industry Authority at Hull.
The model scale chosen was 1 to 10, which supplied nets large enough to show details, but too big to allow a complete full scale rig to be tested.

4.2. Nets and rigging

Drawings of the scale models of these nets are given in figures 1e,f,g for nets A, B and C. No model drawing is available from net D.
A sketch of the rigging is given in figure 2.
Sweeps and bridles were considerably shorter than those used in full scale tests due to size limits of the tank.
A sound comparison will therefore be hard to do. Only a rough correlation between model and full scale values can be expected, also due to scale effects.
The values quoted in the rigs are full scale values.
Rather small flat wooden model doors were used equivalent to 3.4 m^2 at full scale for nets A and B. V-doors equivalent to 8 ft full scale doors were used for net C. On the headline of nets A and B a total of 21 floats were attached of a diameter of 20 mm each, resulting in a total buoyancy of 67.2 kg (full scale value).
Net C had a total of 49 floats on the headline of equal diameter, giving a buoyancy of 156.8 kg (full scale).

4.3. Test results for nets A and B

The measurements are given in table 6 at a speed of 3.0, 4.0 and 5.0 knots.
The influence of lengthening the split bridles by 6.10 m is a slight increase in headline height for all speed values. At 4.0 knots the rise is only 7 cm. The biggest headline height turns out to be 2.30 m.
The wing-end and door spread values are rather small.
An average ratio of wing-end spread/door spread is 0.465 for all measurements on this gear.
Small underwater load cells were used to measure the loads in the warps. The sum of these values is also given in table 6.
The model of net B shows slightly higher values of the headline height with 2.60 m as a maximum value at 3.0 knots and with the sweeps lengthened by 6.10 m as may be expected.
The door spread values are slightly bigger, and the wing-end spreads are very similar to those of net A.
The average wing-end spread/door spread ratio is 0.460 for this net.

4.4. Test results for net C

Net C has a lot more headline height with 5.0 m as a maximum value at 3.0 knots speed with a twin bridle system.
The door spread of this gear is approximately 7 m bigger than of nets A and B.
The wing-end spread/door spread ratio for this net and rigs is on average 0.401.
Twin bridles do cause the wing-ends and headline to lift up almost 0.50 m.

4.5. Results for net D

The measurements are given in table 6 at speeds of 2.0, 3.0 and 4.0 knots. The headline height decreases rapidly with speed.
At 2.0 knots the height is almost 7.5 m, while at 4.0 knots it has diminished with 3.20 m.
The wing-end spread seems to be invariant, but this is partly due to the short bridles used and the different spreading power of model doors. From all the nets this net opens best in vertical and horizontal direction.

4.6. Comparison with full scale measurements

For model nets A, B and C the door and wing-end spreads are considerably less than for the full scale nets. The difference from the lowest full scale wing-end spread values is approximately 4.0 m.
The wing-end spread values of net D do coincide with the upper boundary of the full scale values.
The heights of the model loggernets A and B are quite similar at 3.0 knots and almost 1.0 m less than the full scale values at 5.0 knots.
The heights of model net C are comparable to the lowest heights found at full scale (haul pair no. 7), while the values of net D are well in the upper region of the full scale values.
The sweep divergence angles of models A, B and C are almost 5 degrees less than the lowest values of the full scale nets at 4.0 knots.
No data are available for net D as door spread readings are missing.
The gear drag values for model nets A, B and D are very much similar to the net drag values of the full scale nets. This may be expected as the warps are much shorter for the model nets and the otterboards do have a different spread characteristic due to the absence of a bottom contact comparable to reality.
For model net C the drag values are somewhere half between the gear and net drag figures.

5. CONCLUSIONS AND RECOMMENDATIONS

An extended set of data on gear geometry and drag has been recorded for some commonly used nets of the Dutch fleet.
With the aid of this data it is easier to match gears to existing vessels as requirements for the power needed to tow such gears are known now.
The 850 kg (4.5 m^2) polyvalent doors do result in a substantially bigger door spread with the same warp and sweep lengths as found with a V-door of 5.5 m^2 weighing 830 kg for net B.
In other words the polyvalent doors are hydrodynamically better spreading devices. However there may be practical reasons to prefer V-doors, such as their ease to handle and the fact that they will rise easily after falling flat on the seabed.
The towing efficiency may be improved by 30%, with a difference in drag of 1.5 tonnes. For net B however no such improvement was found however.
With floats and kites mounted to a headline of a trawl it is easy to increase the horsepower needed on the shaft with 100 hp.
Kites are more effective to open a trawl than floats, even at low speeds, but model experiments show that the effect is very local.
Shorter sweeps usually lead to bigger vertical openings of these nets, and smaller spread values, as may be expected. In spite of the reduction in drag of shorter sweeps due to a smaller length of cable running over the seabed, the gear drag may be higher due to the rise in headline height.
An increase of 30% in swept volume index has been found for net A.
For net B the indices are similar, for both long and short sweeps.
The influence of door dimensions on the performance of a gear has been illustrated by replacing 10 ft V-door by 8 ft V-door with a 42% smaller surface area with net B.
The result is a drastic decrease in spread and sweep divergence angle and an increase of the gear drag in the range 1.5 and 2.0 tonnes.
The headline height for this trawl rises approximately 1.0 m at high speeds.
The towing efficiency turns out to be 60% better, and a decrease in horsepower of 100 hp is found with this ship, the research vessel "Tridens".
From these measurements it is clear, that real fuel savings must be sought in a proper match of a door to a particular net.
Paying out more warp generally does not effect the gear dimensions much, but will increase the total drag according to the additional warp drag.
It is dependent on the force equilibrium of the doors however, what the outcome will be. When the spreading power of the doors is big for a gear, a longer warp length will enable the doors to spread the net more as can be seen with net C, resulting in less headline height.
The towing efficiency may be better with short warps, because of the larger mouth area. One should take care not to pay out to much warp length with bottom trawls. The minimum amount to keep the boards in a steady position on the seabed seems to be enough.
With nets like net C an extension of the upper bridle may easily result in an increase in headline height. With an extension of only 90 cm a rise of 1.0 m has been found, resulting in an increase of towing efficiency of 42% due to the larger mouth area, but one has to pay for it with slightly higher values of the shaft horsepower. It depend on the species of fish to be caught whether such a rig alteration is worthwhile.
The balloon trawl net D shows some different reactions from the ones

described before.
Attaching longer sweeps does result in an increase of headline height with 40 floats and the same applies to the door and wing-end spread values.
With more floats added to it the headline height diminishes with long sweeps. The longer the sweeps are, the better the swept volume index with 40 floats. Steps up of 10 fathoms result in an increase in 30% with this parameter for the case of 40 floats. The picture is reverse with 54 floats attached to the headline.
Gear and net drag however are not noticably effected.
A variation of the angle of attack of the smallest V-doors does not affect all parameters substantially. There may be practical resasons such as the quicker reaction of the otterboards when paying out to choose a higher value of the attack angle than is needed from a hydrodynamical point of view. Another advantage of a large angle may be the better production of sand clouds as the boards are partially stalled, during the fishing operation.
Floats, usually lift the headline which of course is their purpose.
Net D showed a different reaction on sweep length alteration with 54 floats than with 40 floats. The total buoyancy of these floats is a better indication of the differences in lifting force,than the number is,for 40 Nokalon 2 liter floats do have a lift force of 70.8 kgf while for the total of 40 x 2 ltr + 14 x 10 ltr floats this force equals 209.4 kgf, a difference of about 200%.
The extra floatation alters the slope of the headline versus speed curve so that at low speeds the height will be bigger, but at high speeds the height will be smaller.
The drag of the floats are not to be determined by the differences in gear or net drag. Due to the alteration of net openings, the angle of incidence of the meshes alter, thus changing the drag of the net also.
In other words both drag components are measured at the same time without the possibility to distinguish one from another.
For net D the rise in mouth area due to the additional floats causes the door spread to diminish resulting in a quite similar gear drag and shaft horsepower
The model experiments in a flume tank at a scale of 1 to 10 were mostly done with different lengths of sweeps and bridles and with different sizes of otterboards, than the full scale values.
The full scale experiments were done later in the year with rigging sizes more adjusted to the ones used in reality.
For this reason a comparison with full scale values does not hold to a great extend.
The horizontal dimensions of the model gears are much smaller than in reality.
The headline heights of the loggernets decline much more rapidly with speed for the model scale than the full scale. The other nets C and D show a better agreement with the full scale tests.
It is difficult to compare drag measurements of models to full scale nets, as for the models the interaction of otterboards and the seabed cannot be simulated correctly. In most cases the size of a model does not allow a complete net and rigging including the full length of warps to be examined. The towing points used need to be adjusted to certain length/depth ratios and a board spread measured at full scale.
Drag comparisons of the models themselves will enable a qualitive judgement as to which gear tows at the lowest drag.
In a number of occasions a lineair regression to the points will not lead to a very representative picture, especially at high speeds.

Especially door spread values are erronous when the otterboards fall down at low speeds. A new type of regression formula will be needed for these cases.
Variations in depth during one haul pair could not be avoided in some cases. One should always try to do both hauls at the same location and along the same track to avoid discrepancies found from different seabed conditions.
When performing trials on bottom trawls one should always try to get as much information on the fishing ground as possible. An accurate reading of the position of the experiment is very essential.

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TABLE 1 :EXPERIMENTS 1982 BOTTOMTRAWLS

AUGUST 1982

HAUL PAIRNR	HAUL NRS	NET	RIG	WARPLENGTH (M)	DEPTH (M)	OTTERBOARDS	BACKSTROP LENGTH (M)	SWEEP LENGTH (M)	BRIDLE LENGTH (M)	FLOATATION	KITES
1	1,2	A	1	500	92	P-850	4.5	100	40/40	12*10 LTR	-----
2	3,4	A	2	500	95	P-850	4.5	100	40/40	13*10 LTR	60*80
3	5,6	A	3	500	85	P-850	4.5	100	40/40	3*10 LTR	60*80
4	7,8	B	3	500	88	P-850	4.5	100	40/40	3*10 LTR	60*80
5	9,10	B	4	500	89	V-10	4.5	100	40/40	13*10 LTR	60*80
6	11,12	B	5	500	88	V-10	4.5	100	40/40	3*10 LTR	60*80
7	13,14	C	6	500	98	V-10	4.5	100	40/40	22*10 LTR	-----
8	15,16	C	7	500	95	V-10	4.5	100	40.9/40	22*10 LTR	-----
9	17,18	C	7	300	88	V-10	4.5	100	40.9/40	22*10 LTR	-----

OCTOBER 1982

HAUL PAIRNR	HAUL NRS	NET	RIG	WARPLENGTH (M)	DEPTH (M)	OTTERBOARDS	BACKSTROP LENGTH (M)	SWEEP LENGTH (M)	BRIDLE LENGTH (M)	FLOATATION	KITES
10	19,20	A	8	700	240	V-10	4.5	60	39/39	12*10 LTR	-----
11	21,22	A	9	500	115	V-10	4.5	100	39/39	12*10 LTR	-----
12	23,24	A	10	500/700	116/25	V-10	4.5	100	39/39	3*10 LTR	60*80
13	25	C	11	500	110	V-10	4.5	100.9/100	--	22*10 LTR	-----
14	26,27	B	12	500	88	V-10	4.5	60	39/39	12*10 LTR	-----
15	28,29	B	13	350	60	V-10	4.5	60	39/39	3*10 LTR	60*80
16	30,31	B	13	500	113	V-10	4.5	60	39/39	3*10 LTR	60*80
17	32,33	B	14	350	115	V-8	4.5	60	39/39	3*10 LTR	60*80
18	34,35	D	15	300	56/75	V-8/C2	9.0	56.86	42/46.7	40*2 LTR	-----
19	36,37	D	16	300	63	V-8/C2	9.0	38.58	42/48.5	40*2 LTR	-----
20	38,39	D	17	300	58	V-8/B2	9.0	20.29	42/48.5	40*2 LTR	-----
21	40,41	D	18	300	57/70	V-8/A1	9.0	20.29	42/48.5	40*2 LTR	-----
22	42,43	D	19	300	62	V-8/A1	9.0	20.29	42/48.5	40*2+14*10	-----
23	44,45	D	20	300	56	V-8/A1	9.0	56.86	42/48.5	40*2+14*10	-----
24	46,47	D	21	300	55	V-8/A1	9.0	38.38	42/48.5	40*2+14*10	-----

REMARKS:

NET A = LOGGERNET (20 CM MESHES IN SQUARE)
NET B = LOGGERNET (40 CM MESHES IN SQUARE)
NET C = SCOTTISH TYPE OF TRAWL, BOBBIN TRAWL
NET D = BALLOON TRAWL BY S.F.I.A.

HAUL PAIR NRS. 1 TO 17 FISHED WITH 28.00 MM WARPS
HAUL PAIR NRS. 18 TO 24 FISHED WITH 20.00 MM WARPS
DURING HAUL 25 NET C WAS LOST ON A WRECK.

TABLE 2 : GEAR GEOMETRY REGRESSION RESULTS FOR HAULPAIRS 1 TO 12.

		NET A			NET B			NET C			NET A		
HAULPAIRNR		1	2	3	4	5	6	7	8	9	10	11	12
DOOR SPREAD (M)	3 KN	137.61	93.59	124.81	119.82	119.93	132.25	96.58	98.28	89.09	95.40	104.83	104.10
	4 KN	123.01	118.72	126.64	123.65	118.90	130.30	94.94	99.94	85.50	92.93	101.31	104.02
	5 KN	108.41	143.84	128.47	127.48	117.86	128.36	93.31	101.61	81.91	90.46	97.79	103.95
W/E SPREAD (M)	3 KN	27.25	24.78	27.55	23.97	22.55	24.86	21.74	22.12	20.05	19.09	20.47	19.38
	4 KN	24.36	23.56	27.64	24.76	22.35	24.50	21.37	22.49	19.24	18.07	19.17	19.38
	5 KN	21.47	22.34	27.73	25.56	22.16	24.13	21.00	22.87	18.44	17.05	17.86	19.38
H/L HEIGHT (M)	3 KN	1.76	4.10	2.13	1.89	3.37	1.64	4.94	5.79	7.22	3.76	2.41	2.92
	4 KN	2.09	3.70	2.58	2.23	3.21	2.15	4.37	5.41	5.86	4.29	2.74	3.17
	5 KN	2.41	3.31	3.04	2.58	3.04	2.66	3.80	5.04	4.49	4.82	3.07	3.42
DOOR DEPTH (M)	3 KN	94.21	92.54	94.23	85.36	89.06	89.51	100.53	95.94	88.47	229.23	110.63	225.87
	4 KN	94.18	91.53	92.99	83.74	88.59	89.46	99.51	95.87	88.03	231.81	116.35	175.05
	5 KN	94.15	90.52	91.76	82.12	88.12	89.41	98.48	95.79	87.58	234.39	122.07	124.42
MOUTH AREA (M2)	3 KN	49.73	101.95	59.85	45.17	76.11	41.57	107.41	127.99	144.64	72.08	49.37	56.74
	4 KN	50.86	87.25	71.70	55.46	71.71	52.40	93.45	121.88	112.82	77.36	52.61	61.55
	5 KN	51.98	72.55	83.56	65.74	67.30	63.24	79.48	115.77	81.00	82.64	55.85	66.37
PORT WARP DECLINATION (DEG)	3 KN	19.29	18.73	19.51	17.92	18.61	17.34	17.39	17.76	20.80	23.83	19.20	27.98
	4 KN	16.66	15.37	16.32	15.32	15.10	15.29	15.13	15.10	19.36	21.47	17.66	22.01
	5 KN	14.04	12.01	13.14	12.72	11.59	13.24	12.88	12.43	17.92	19.11	16.12	16.04
PORT WARP DIVERGENCE (DEG)	3 KN	5.67	4.08	5.13	5.16	5.26	6.17	4.68	4.66	7.41	2.79	4.71	4.61
	4 KN	5.24	5.43	5.51	5.51	5.58	6.07	4.58	4.76	7.07	2.73	4.55	4.69
	5 KN	4.82	6.79	5.89	5.86	5.90	5.97	4.49	4.85	6.73	2.67	4.38	4.78
STARBOARD WARP DECLINATION (DEG)	3 KN	18.45	18.00	18.24	17.47	17.19	16.70	16.99	16.99	20.50	23.63	18.40	27.56
	4 KN	16.07	15.23	15.56	14.95	14.71	14.88	15.01	14.76	19.27	21.38	17.21	21.73
	5 KN	13.69	12.45	12.89	12.43	12.22	13.06	13.02	12.54	18.03	19.13	16.01	15.91
STARBOARD WARP DIVERGENCE (DEG)	3 KN	5.93	4.18	5.51	5.28	5.61	6.33	4.74	4.78	7.54	2.89	4.93	4.72
	4 KN	5.46	5.47	5.78	5.63	5.69	6.21	4.62	4.84	7.16	2.79	4.71	4.76
	5 KN	4.99	6.76	6.06	5.98	5.76	6.09	4.50	4.91	6.78	2.70	4.50	4.79
SWEEP DIVERGENCE (DEG)	3 KN	22.45	13.86	19.70	19.40	19.71	21.84	15.02	15.18	13.73	21.67	17.10	17.19
	4 KN	19.99	19.25	20.06	20.03	19.53	21.50	14.76	15.45	13.17	21.23	16.65	17.17
	5 KN	17.52	24.65	20.42	20.67	19.36	21.16	14.50	15.71	12.61	20.79	16.19	17.15
HAULPAIRNR		1	2	3	4	5	6	7	8	9	10	11	12
		NET A			NET B			NET C			NET A		

TABLE 3 : GEAR PERFORMANCE REGRESSION RESULTS FOR HAUL PAIRS 1 TO 12.

		NET A			NET B			NET C			NET A		
HAULPAIRNR		1	2	3	4	5	6	7	8	9	10	11	12
GEAR DRAG (TONNES)	3 KN	2.44	3.78	2.90	2.98	3.17	4.35	5.76	5.15	4.77	4.77	4.08	4.40
	4 KN	5.23	6.48	5.74	5.76	7.05	6.62	8.63	7.91	7.42	7.27	6.48	6.84
	5 KN	8.02	9.17	8.58	8.54	10.94	8.89	11.49	10.67	10.07	9.77	8.88	9.27
NET DRAG (TONNES)	3 KN	1.69	2.43	1.33	1.44	1.47	1.62	2.71	2.54	1.99	2.07	2.07	2.06
	4 KN	3.19	3.36	3.01	3.08	3.26	2.80	4.17	4.21	3.80	3.27	3.31	3.23
	5 KN	4.70	4.29	4.68	4.71	5.04	3.99	5.62	5.88	5.61	4.47	4.55	4.39
GEAR DRAG/ MOUTH AREA (KGF/M2)	3 KN	53.30	38.72	56.43	74.08	39.10	126.59	54.39	40.33	30.49	67.63	80.67	83.64
	4 KN	103.57	74.81	81.54	103.46	99.47	133.53	93.50	65.17	68.70	94.51	130.93	116.89
	5 KN	153.83	110.90	106.64	132.84	159.84	140.46	132.61	90.01	106.90	121.40	181.18	150.14
NET DRAG/ MOUTH AREA (KGF/M2)	3 KN	36.03	24.35	26.83	37.02	18.03	46.82	25.57	19.85	12.08	29.49	40.74	39.81
	4 KN	63.36	38.87	42.69	55.27	45.90	55.45	45.16	34.75	35.45	42.59	66.73	55.74
	5 KN	90.70	53.39	58.83	73.52	73.77	64.08	64.75	49.65	58.82	55.69	92.71	71.68
SWEPT VOLUME INDEX WITH GD (TONNES/M3,S)	3 KN	25.04	41.29	28.00	20.52	30.61	14.36	28.73	38.35	46.01	22.99	17.69	19.03
	4 KN	20.46	28.09	26.03	20.01	21.71	16.36	22.33	31.72	31.91	22.10	16.82	18.78
	5 KN	15.88	14.90	24.06	19.49	12.82	18.36	15.94	25.09	17.81	21.21	15.96	18.53
SWEPT VOLUME INDEX WITH ND (TONNES/M3,S)	3 KN	38.62	63.83	56.67	40.15	64.82	35.96	60.84	78.34	111.20	52.78	34.38	40.54
	4 KN	33.34	54.05	50.02	37.61	47.02	38.59	46.24	59.63	65.46	49.23	32.92	40.65
	5 KN	28.06	44.26	43.37	35.07	27.22	41.22	31.63	40.91	19.72	45.67	31.46	40.76
SHAFT POWER (HP)	3 KN	486.54	550.02	471.59	433.65	537.92	588.76	642.66	607.22	552.58	468.61	418.06	493.01
	4 KN	730.11	833.93	774.94	745.02	834.00	802.82	954.56	886.73	821.73	746.00	683.84	707.49
	5 KN	973.69	1117.84	1078.30	1056.40	1130.07	1016.87	1266.45	1166.25	1090.88	1023.40	949.63	921.98
GEAR POWER (HP)	3 KN	24.23	71.54	42.87	38.50	47.31	78.32	117.47	106.42	94.34	89.65	67.57	80.47
	4 KN	146.18	179.96	160.58	161.00	198.05	186.26	237.21	216.59	207.48	203.16	181.55	192.48
	5 KN	268.13	288.38	278.28	283.49	348.79	294.20	356.95	326.75	320.62	316.47	295.52	304.48
HAULPAIRNR		1	2	3	4	5	6	7	8	9	10	11	12
		NET A			NET B			NET C			NET A		

TABLE 4 : GEAR GEOMETRY REGRESSION RESULTS FOR HAUL PAIRS 13 TO 24.

		NET C	NET B				NET D						
HAULPAIRNR		13	14	15	16	17	18	19	20	21	22	23	24
DOOR SPREAD	3 KN	101.19	116.48	118.60	116.51	81.48	77.82	66.78	60.70	50.56	57.26	57.87	64.57
(M)	4 KN	94.78	116.16	111.60	111.84	78.53	70.91	63.86	60.07	61.32	56.34	84.56	66.64
	5 KN	88.37	115.83	104.61	107.17	75.59	64.00	60.95	59.44	72.09	55.43	111.26	68.70
W/E SPREAD	3 KN	22.77	21.88	22.29	21.93	16.69	16.51	15.23	15.19	14.73	14.94	14.26	14.72
(M)	4 KN	21.33	21.83	20.93	21.03	16.15	14.20	14.56	14.75	15.87	14.68	15.87	15.01
	5 KN	19.88	21.77	19.58	20.13	15.62	11.89	13.90	14.30	17.01	14.43	17.47	15.29
H/L HEIGHT	3 KN	5.33	2.40	2.27	2.95	2.34	5.14	3.95	3.25	3.51	5.16	5.10	4.66
(M)	4 KN	5.24	2.67	2.33	2.94	3.02	5.20	3.56	3.08	3.19	4.69	3.85	3.81
	5 KN	5.15	2.93	2.40	2.93	3.70	5.27	3.17	2.91	2.88	4.22	2.61	2.95
DOOR DEPTH	3 KN	114.29	90.37	55.77	116.28	59.58	70.52	63.99	58.64	60.44	60.94	56.90	53.76
(M)	4 KN	111.88	88.77	60.42	114.72	59.47	60.30	59.13	55.44	61.36	62.77	55.01	53.17
	5 KN	109.47	87.18	65.07	113.16	59.36	50.08	54.26	52.25	62.27	64.59	53.13	52.58
MOUTH AREA	3 KN	121.00	52.58	50.73	64.24	39.64	85.06	60.10	49.32	51.35	76.96	72.17	68.49
(M2)	4 KN	111.76	58.21	48.78	61.72	48.64	73.64	51.81	45.39	50.79	68.85	62.91	57.23
	5 KN	102.52	63.84	46.82	59.20	57.64	62.22	43.51	41.46	50.23	60.75	53.65	45.97
PORT WARP	3 KN	19.02	18.67	15.32	19.82	17.02	18.78	18.35	17.13	18.46	17.55	17.36	16.63
DECLINATION	4 KN	17.08	15.66	14.43	17.67	15.31	15.56	15.15	14.79	15.69	15.58	13.56	14.11
(DEG)	5 KN	15.13	12.66	13.54	15.53	13.61	12.33	11.95	12.44	12.92	13.61	9.76	11.59
PORT WARP	3 KN	4.59	5.24	8.08	5.23	5.13	6.20	5.21	4.73	3.78	4.41	4.46	5.02
DIVERGENCE	4 KN	4.33	5.34	7.62	5.04	4.96	5.50	4.98	4.65	4.73	4.35	6.83	5.27
(DEG)	5 KN	4.07	5.44	7.16	4.84	4.79	4.81	4.76	4.57	5.68	4.29	9.21	5.52
STARBOARD WARP	3 KN	18.63	17.53	14.54	19.24	16.34	18.43	17.97	16.90	18.28	17.28	17.02	15.98
DECLINATION	4 KN	16.81	15.07	13.94	17.30	14.83	15.10	14.95	14.55	15.38	15.47	13.10	14.04
(DEG)	5 KN	15.00	12.60	13.34	15.37	13.32	11.76	11.94	12.21	12.47	13.65	9.19	12.11
STARBOARD WARP	3 KN	4.69	5.46	8.32	5.41	5.28	6.26	5.27	4.77	3.81	4.45	4.53	5.12
DIVERGENCE	4 KN	4.41	5.50	7.81	5.19	5.09	5.66	5.04	4.69	4.81	4.39	6.91	5.29
(DEG)	5 KN	4.14	5.55	7.31	4.96	4.90	5.06	4.82	4.62	5.81	4.33	9.28	5.46
SWEEP	3 KN	22.08	27.23	27.74	27.22	18.08	16.53	16.75	18.65	14.61	17.30	11.71	16.22
DIVERGENCE	4 KN	20.62	27.14	26.01	26.06	17.39	15.26	16.00	18.57	18.62	17.02	18.48	16.81
(DEG)	5 KN	19.17	27.06	24.29	24.96	16.70	13.99	15.25	18.49	22.63	16.75	25.24	17.41
HAULPAIRNR		13	14	15	16	17	18	19	20	21	22	23	24
		NET C	NET B				NET D						

TABLE 5 : GEAR PERFORMANCE REGRESSION RESULTS FOR HAUL PAIRS 13 TO 24.

		NET C	NET B				NET D						
HAULPAIRNR		13	14	15	16	17	18	19	20	21	22	23	24
GEAR DRAG (TONNES)	3 KN	3.66	3.93	3.25	3.95	2.46	2.88	2.76	2.79	2.58	2.71	2.85	2.68
	4 KN	6.77	6.50	5.82	6.31	4.37	4.21	4.40	4.23	4.25	4.47	4.56	4.45
	5 KN	9.87	9.07	8.39	8.67	6.28	5.53	6.05	5.67	5.92	6.24	6.27	6.21
NET DRAG (TONNES)	3 KN	1.90	1.71	1.27	1.65	1.38	1.71	1.59	1.63	1.64	1.69	1.95	1.69
	4 KN	3.83	2.83	2.50	2.69	2.47	2.26	2.60	2.59	2.67	2.91	3.08	2.89
	5 KN	5.76	3.94	3.72	3.73	3.57	2.81	3.61	3.55	3.70	4.12	4.21	4.09
GEAR DRAG/ MOUTH AREA (KGF/M2)	3 KN	25.19	75.80	53.77	54.17	71.28	34.20	47.22	56.69	50.39	34.84	40.37	38.31
	4 KN	60.81	110.17	118.79	104.25	89.93	56.79	84.53	93.64	85.49	64.56	70.48	77.41
	5 KN	96.43	144.55	183.82	154.33	108.59	79.39	121.85	130.59	120.59	94.28	100.59	116.50
NET DRAG/ MOUTH AREA (KGF/M2)	3 KN	12.69	33.00	20.51	22.50	40.18	20.44	27.13	33.15	32.08	21.67	27.67	24.04
	4 KN	34.47	47.88	50.92	44.35	50.95	30.67	49.86	57.33	53.86	41.96	47.79	50.28
	5 KN	56.25	62.76	81.34	66.21	61.72	40.89	72.59	81.50	75.64	62.25	67.91	76.52
SWEPT VOLUME INDEX WITH GD (TONNES/M3,S)	3 KN	42.66	20.41	20.36	23.35	22.13	45.48	34.52	27.24	32.62	43.19	41.11	38.56
	4 KN	34.52	18.91	17.33	20.49	22.94	36.07	24.08	22.24	24.61	31.25	24.41	26.45
	5 KN	26.38	17.40	14.30	17.64	23.76	26.66	13.65	17.24	16.60	19.30	7.71	14.33
SWEPT VOLUME INDEX WITH ND (TONNES/M3,S)	3 KN	78.73	46.57	49.05	56.70	39.44	77.88	60.12	46.32	49.83	69.06	59.41	61.02
	4 KN	61.69	43.55	40.56	48.65	40.67	67.40	41.04	36.50	39.45	47.94	37.70	40.58
	5 KN	44.64	40.52	32.07	40.61	41.90	56.91	21.95	26.69	29.06	26.82	15.99	20.14
SHAFT POWER (HP)	3 KN	323.49	569.20	374.69	487.49	311.72	297.85	369.02	337.97	296.83	264.18	361.83	306.09
	4 KN	643.09	764.13	626.89	669.81	530.96	492.80	506.80	496.96	395.87	484.71	495.37	486.70
	5 KN	962.70	959.06	879.08	852.13	750.21	687.15	644.66	655.94	494.91	705.24	628.91	667.32
GEAR POWER (HP)	3 KN	43.36	74.33	38.49	67.09	23.87	58.38	58.80	56.70	56.56	54.58	61.18	53.48
	4 KN	189.31	185.84	161.84	180.01	120.77	114.33	120.69	116.79	117.03	120.77	117.76	121.31
	5 KN	335.25	297.34	285.19	292.94	217.68	170.28	182.58	176.88	177.51	186.95	174.33	189.15
HAULPAIRNR		13	14	15	16	17	18	19	20	21	22	23	24
		NET C	NET B				NET D						

TABLE 6 : RESULTS OF MODEL EXPERIMENTS APRIL 1982.

RIG 22 , NET A , LOGGERNET (20CM)

SPEED (KN)	TOTAL WARP LOAD (TONNES)	DOOR SPREAD (M)	WING-END SPREAD (M)	SIDELINE SPREAD (M)	WING-END HEIGHT (M)	HEADLINE HEIGHT (M)	SWEEP ANGLE (DEG)
3	2.28	30.8	14.4	9.2	0.76	2.14	12.85
4	3.42	32.0	15.2	10.0	0.70	1.45	13.17
5	4.80	34.0	15.6	10.4	0.50	1.05	14.45

RIG 23 , NET A , LOGGERNET (20CM)

SPEED (KN)	TOTAL WARP LOAD (TONNES)	DOOR SPREAD (M)	WING-END SPREAD (M)	SIDELINE SPREAD (M)	WING-END HEIGHT (M)	HEADLINE HEIGHT (M)	SWEEP ANGLE (DEG)
3	2.53	30.8	14.0	8.8	0.90	2.29	11.27
4	3.61	32.4	14.8	9.6	0.80	1.52	11.81
5	4.93	33.6	16.0	10.0	0.50	1.14	11.81

RIG 22 , NET B , LOGGERNET (40CM)

SPEED (KN)	TOTAL WARP LOAD (TONNES)	DOOR SPREAD (M)	WING-END SPREAD (M)	SIDELINE SPREAD (M)	WING-END HEIGHT (M)	HEADLINE HEIGHT (M)	SWEEP ANGLE (DEG)
3	2.10	30.8	14.4	7.2	0.76	2.44	12.85
4	3.22	32.4	16.0	8.0	0.60	1.83	12.85
5	4.60	34.4	16.4	8.0	0.50	1.37	14.12

RIG 23 , NET B , LOGGERNET (40CM)

SPEED (KN)	TOTAL WARP LOAD (TONNES)	DOOR SPREAD (M)	WING-END SPREAD (M)	SIDELINE SPREAD (M)	WING-END HEIGHT (M)	HEADLINE HEIGHT (M)	SWEEP ANGLE (DEG)
3	2.10	32.0	14.0	7.2	0.80	2.60	12.09
4	3.26	34.0	14.8	8.0	0.76	1.98	12.91
5	4.60	35.6	16.0	8.4	0.50	1.52	13.18

RIG 24 , NET C , BOBBIN TRAWL

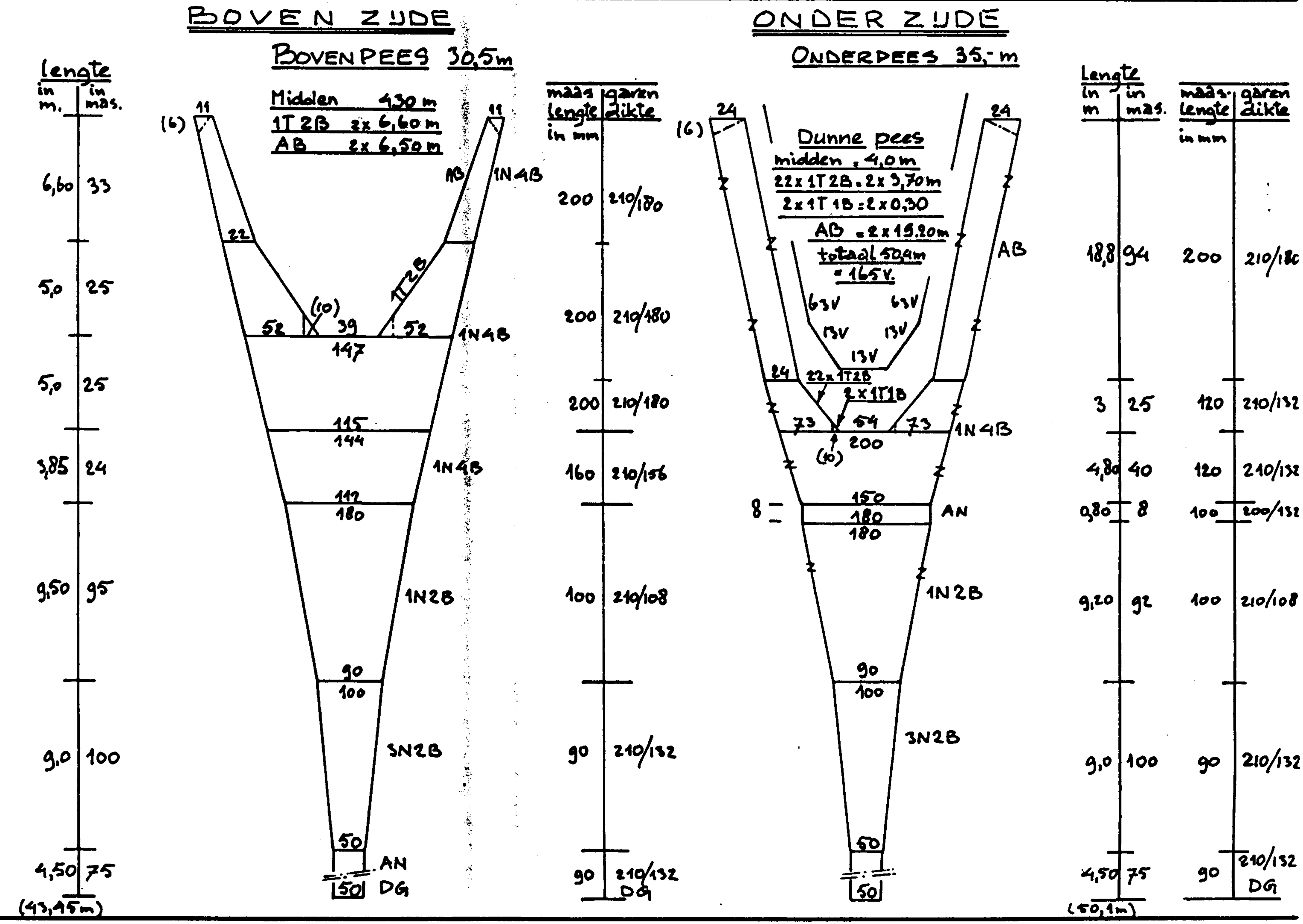
SPEED (KN)	TOTAL WARP LOAD (TONNES)	DOOR SPREAD (M)	WING-END SPREAD (M)	SIDELINE SPREAD (M)	WING-END HEIGHT (M)	HEADLINE HEIGHT (M)	SWEEP ANGLE (DEG)
3	2.55	40.0	16.0	10.8	3.35	5.01	11.54
4	6.11	40.8	16.4	11.2	3.40	4.40	11.73
5	8.60	40.8	16.4	11.2	3.00	4.10	11.73

RIG 25 , NET C , BOBBIN TRAWL

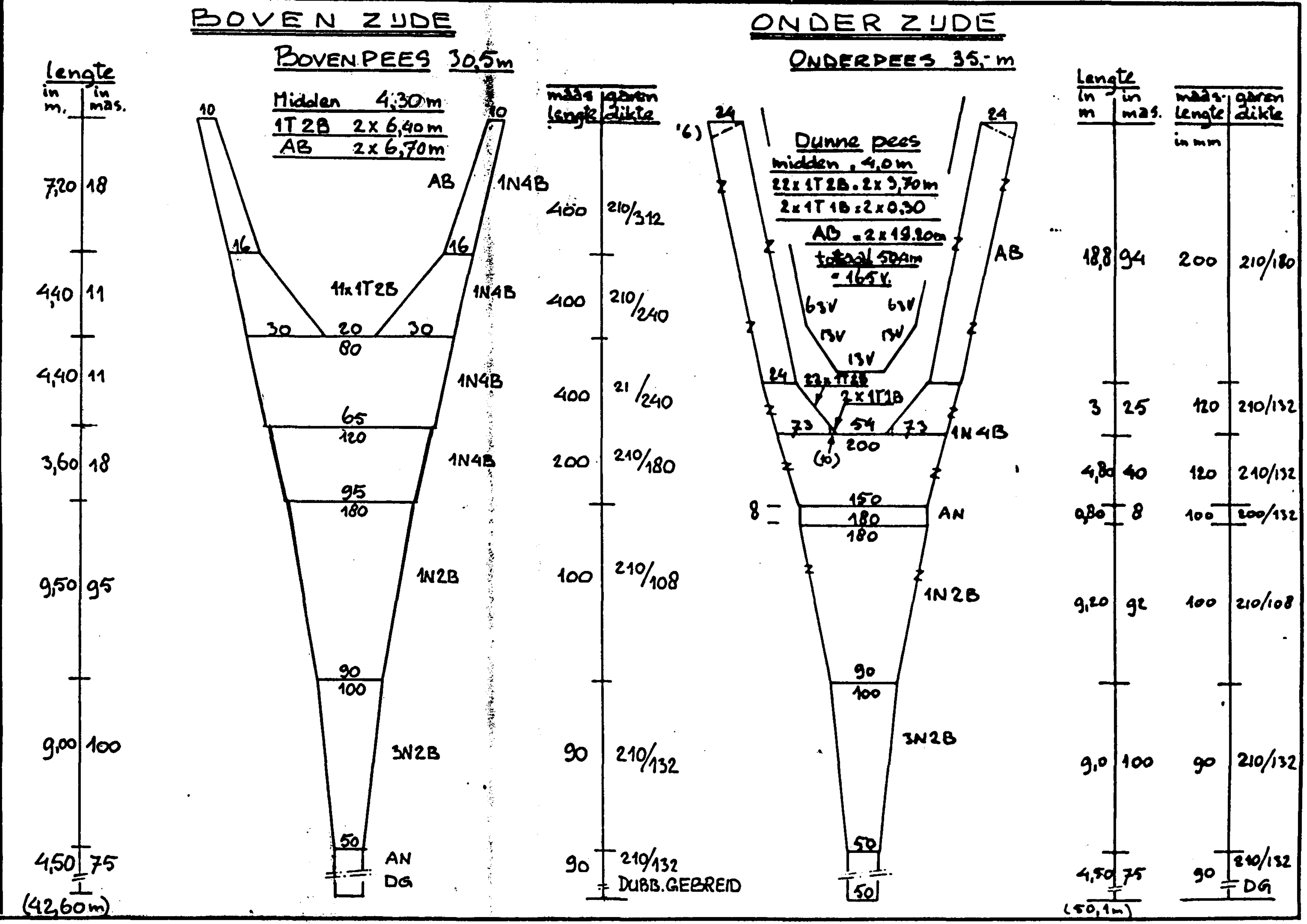
SPEED (KN)	TOTAL WARP LOAD (TONNES)	DOOR SPREAD (M)	WING-END SPREAD (M)	SIDELINE SPREAD (M)	WING-END HEIGHT (M)	HEADLINE HEIGHT (M)	SWEEP ANGLE (DEG)
3	4.68	36.0	14.4	10.4	2.74	4.65	10.37
4	6.56	38.0	15.2	10.8	2.60	3.65	10.95

RIG 26 , NET D , S.F.I.A. BALLOON TRAWL

SPEED (KN)	TOTAL WARP LOAD (TONNES)	DOOR SPREAD (M)	WING-END SPREAD (M)	SIDELINE SPREAD (M)	WING-END HEIGHT (M)	HEADLINE HEIGHT (M)	SWEEP ANGLE (DEG)
2	1.06	-	18.2	9.5	3.96	7.47	-
3	1.84	-	18.0	10.0	3.05	5.49	-
4	2.80	-	18.0	10.0	2.44	4.30	-

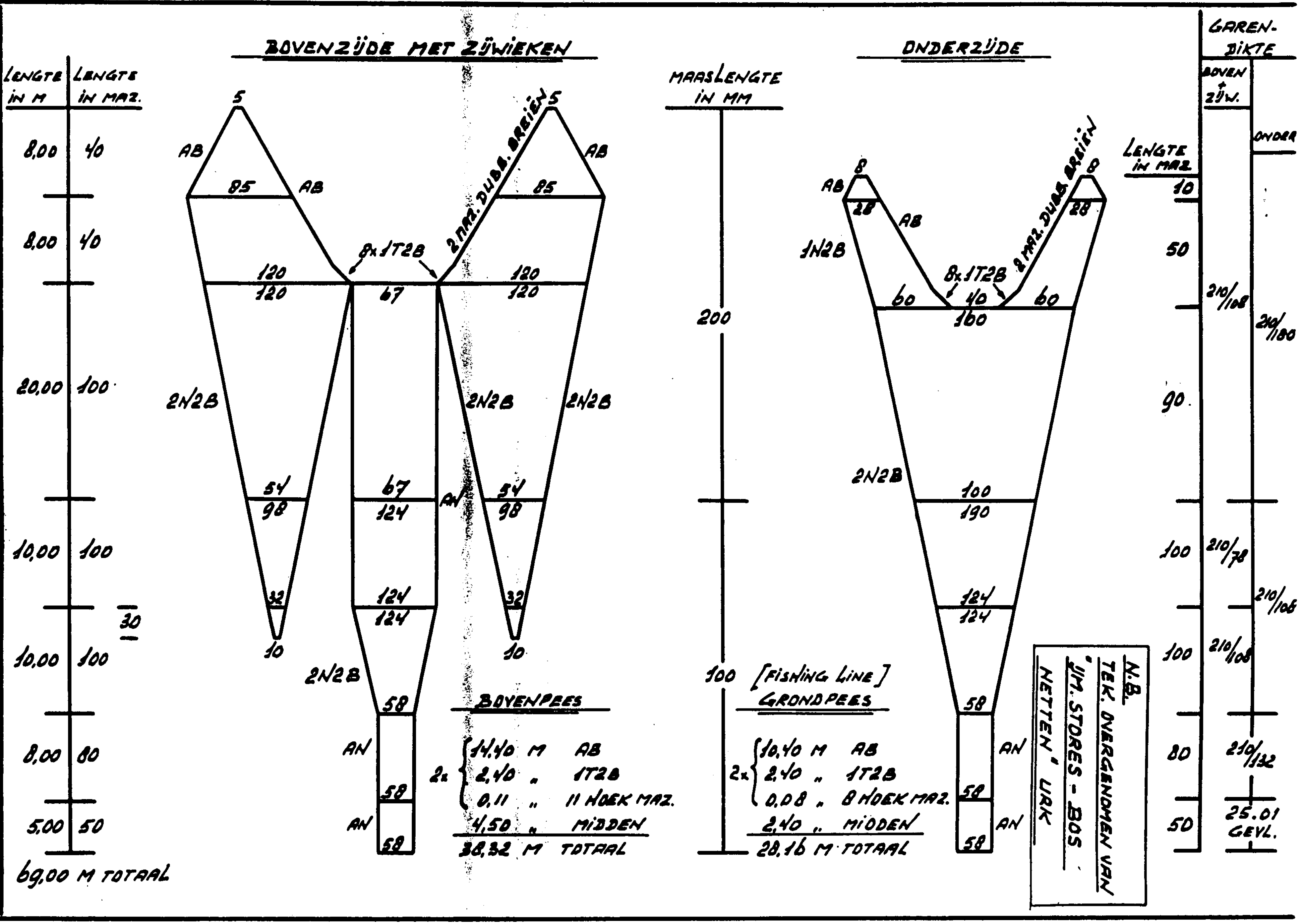


Benaming VERBETERD LOGGERNET Overgenomen van Nettenmakerij Jac. van Duyn Katwijk.		FIG.: 1a NET A
		Formaat A4 — 827
R.I.V.O., afd. Techn. Onderzoek IJmuiden	Schaal	Gecontroleerd
	Getekend	Gezien
		Rangschikmerk



Benaming VERBETERD LOGGERNET
Overgenomen van Nettenmakerij Jac. van Duyn Katwijk.

R.I.V.O., afd. Techn. Onderzoek Ymuiden	Schaal	Gecontroleerd	FIG.: 1b NET B
Auteursrecht voorbehouden volgens de wet	Getekend W.Blom	Gezien 19/1 - '82.	Formaat A4 — 829 — Rangschikmerk



Benaming: "BOBBIN - TRAWL" [SPANZEGEN]			FIG.: 1c NET C
RNO AFD. TECHN. ONDERZ.	Schaal 1:400	Gecontroleerd	Formaat A4 — 804 A
Auteursrecht voorbehouden volgens de wet	Getekend [signature]	Gezien 18-9-'80	Rangschikmerk

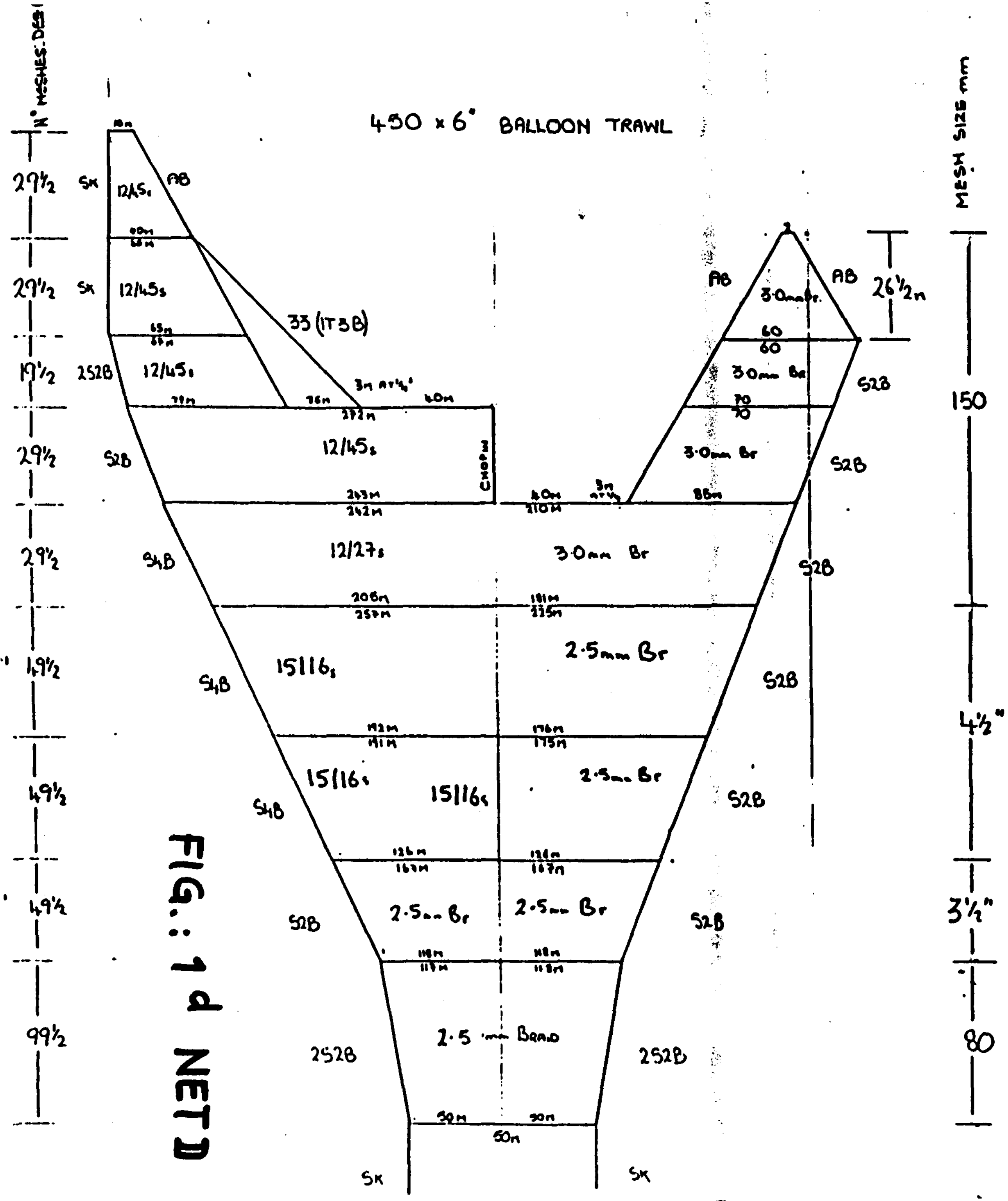
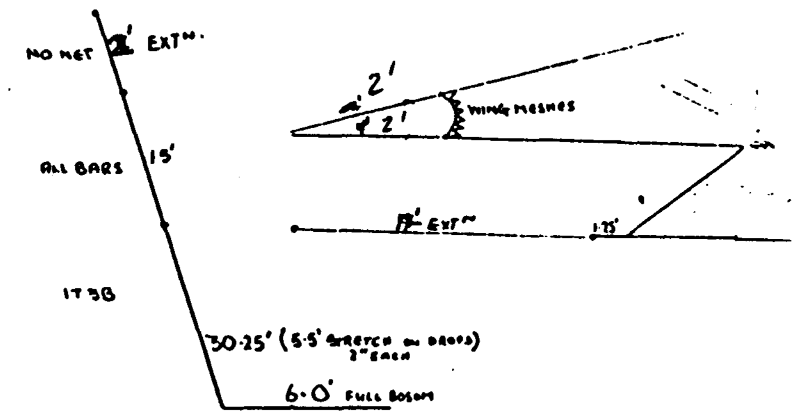


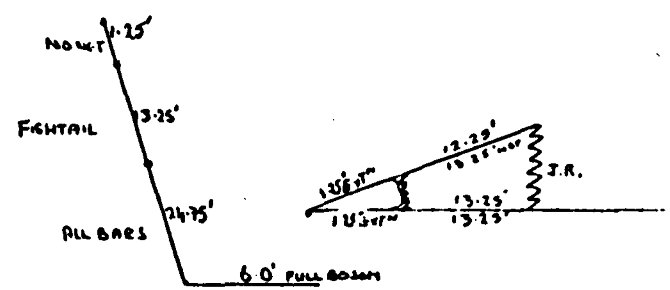
FIG.: 1d NET D

ROPING OUT DETAILS

Headline — TOTAL LENGTH : 100.5' (3
CONSTRUCTION : 14-16mm Combinat



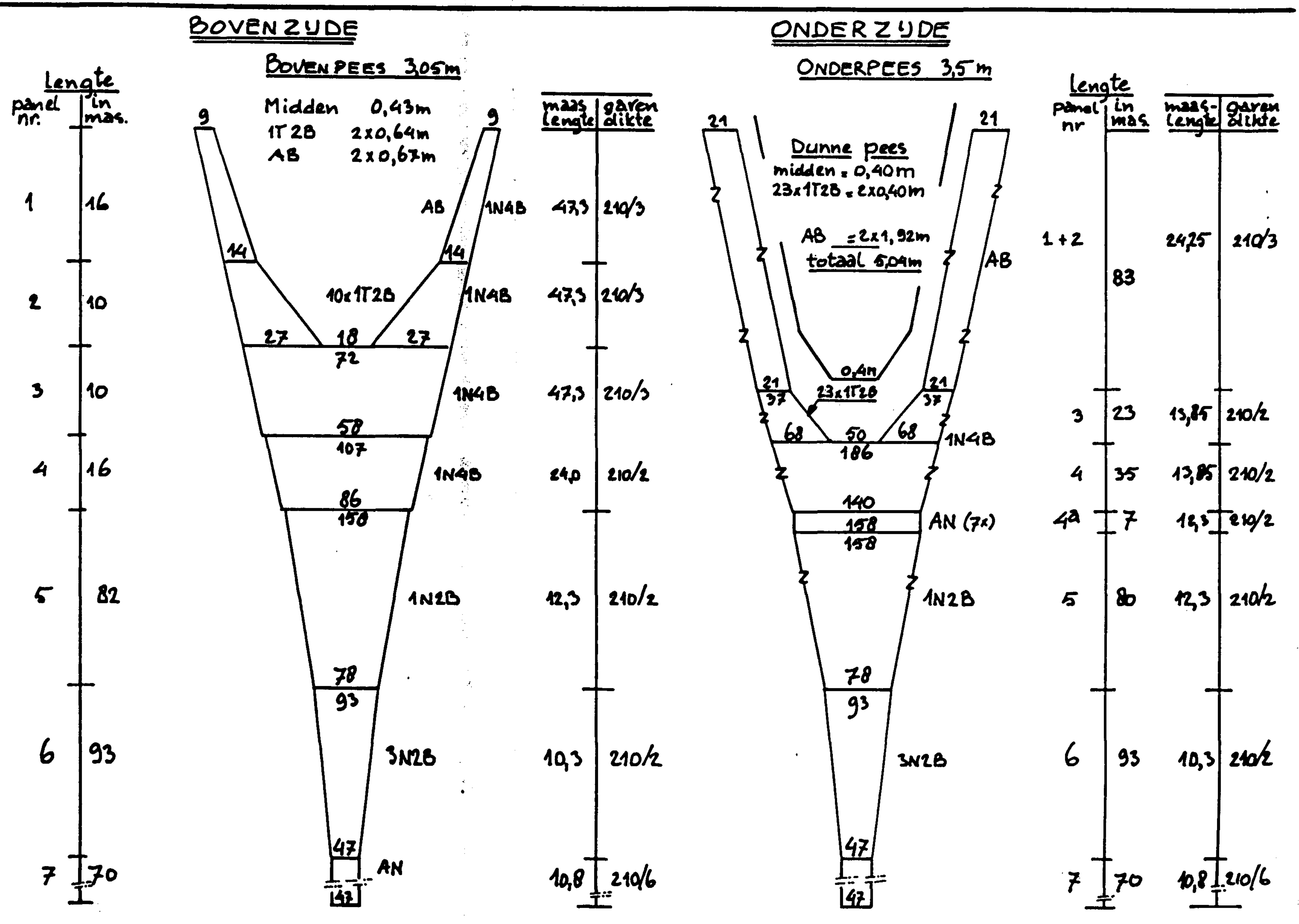
FISHING LINE — TOTAL LENGTH : 85.5' (26m)
CONSTRUCTION 16-18mm Combination



TOP VEE LINE 4mm Combination LENGTH = 27.25' + 2' EX

LOWER VEE LINE 14mm Combination LENGTH = 12.25' + 1' EXT

Checked 16/04/82



Benaming MODEL 1:10 VAN
VERBETERD LOGGERNET (Jac. v. Duin) tek. 829

FIG. 1e model B

Formaat A4 | 829(1)

R.I.V.O. afd. Techn. Onderzoek
IJmuiden - Holland.

Schaal Bu. Morlen | Gecontroleerd

Getekend W. Bloem | Gezien 3/2 - '82

Rangschikmerk

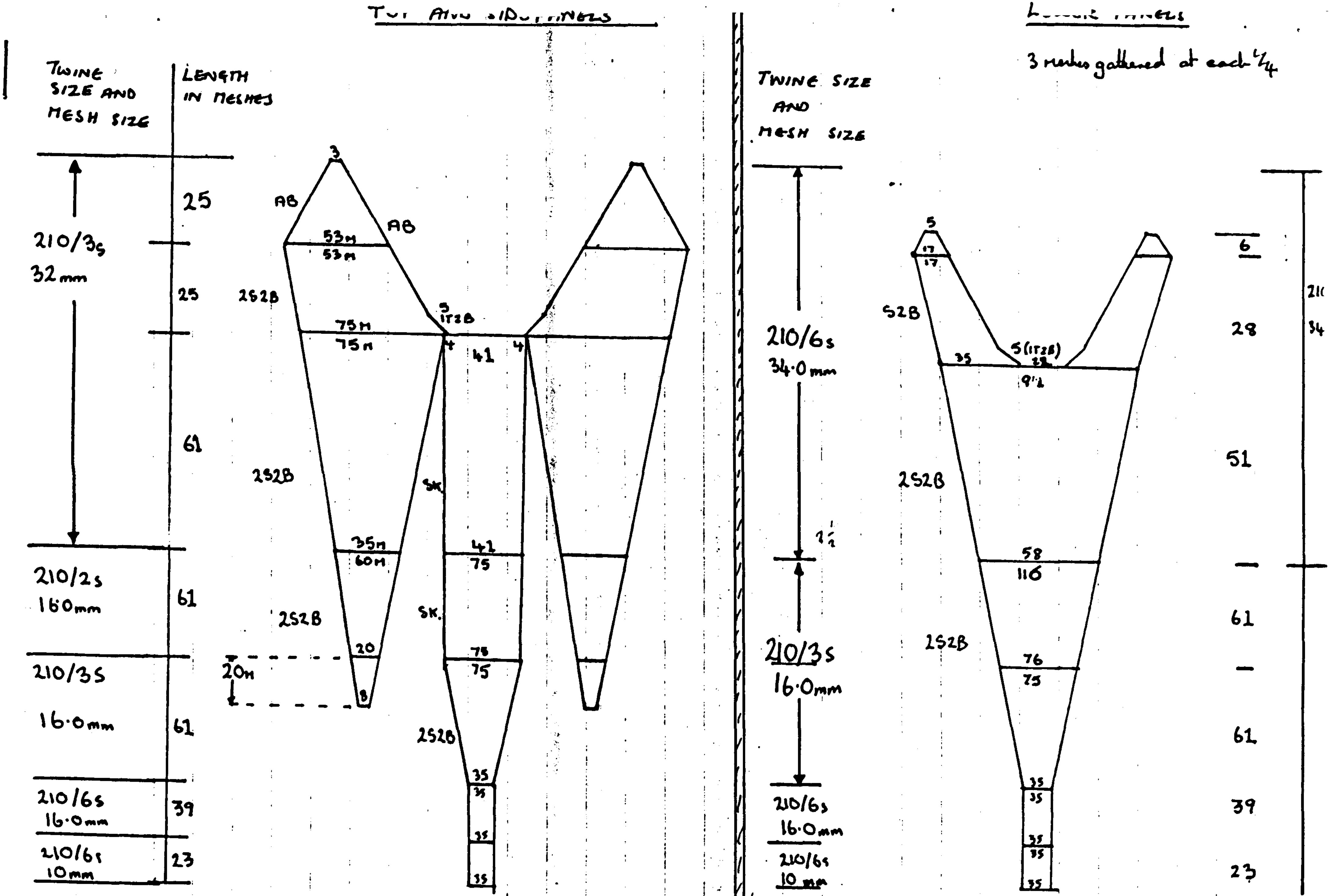


FIG.1[f] 1:10. SCALE MODEL NET C

FIGURE 2ª RIGS USED 1982 FULL SCALE

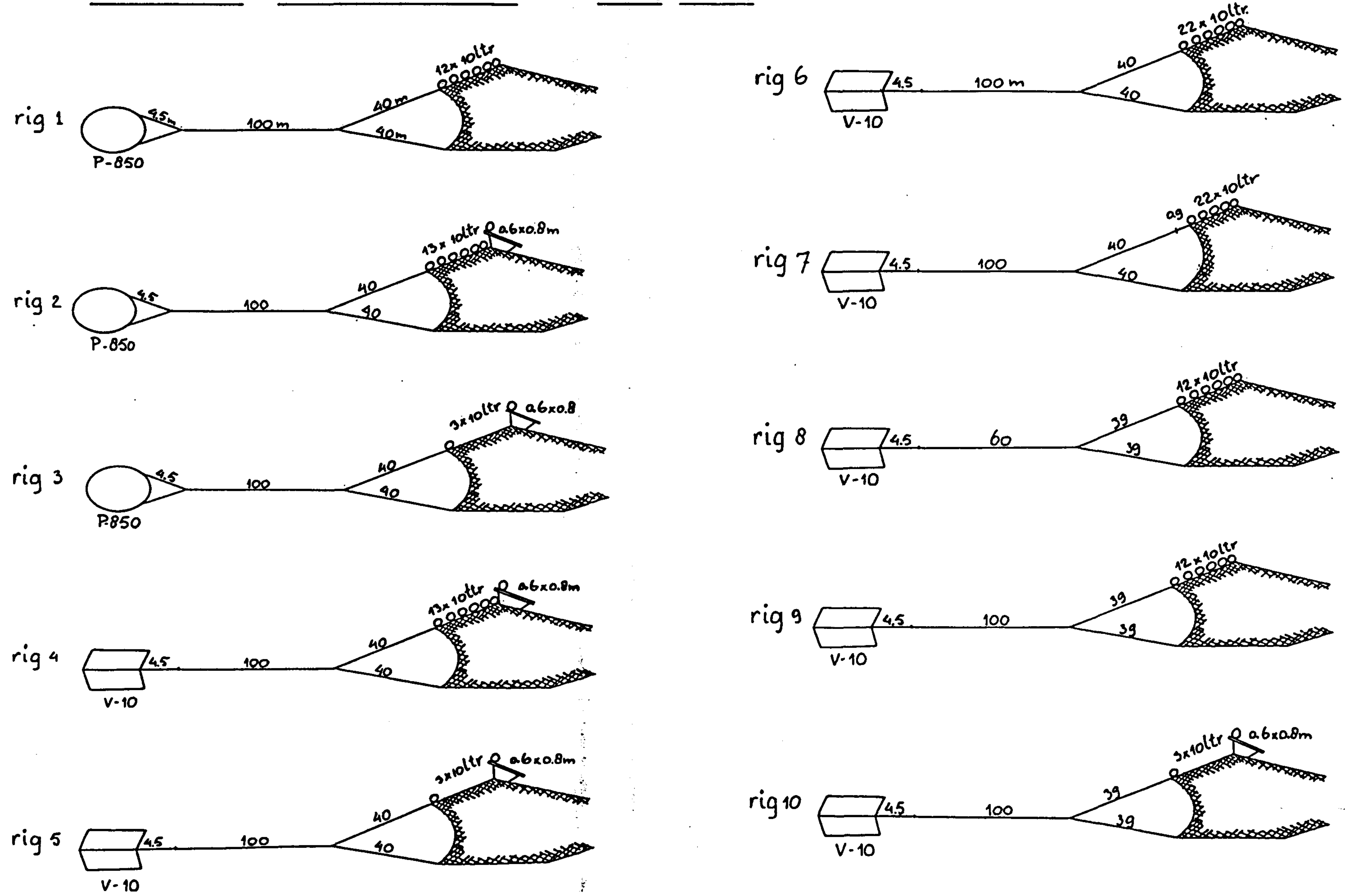


FIGURE 2ᵃ cont. FULL SCALE

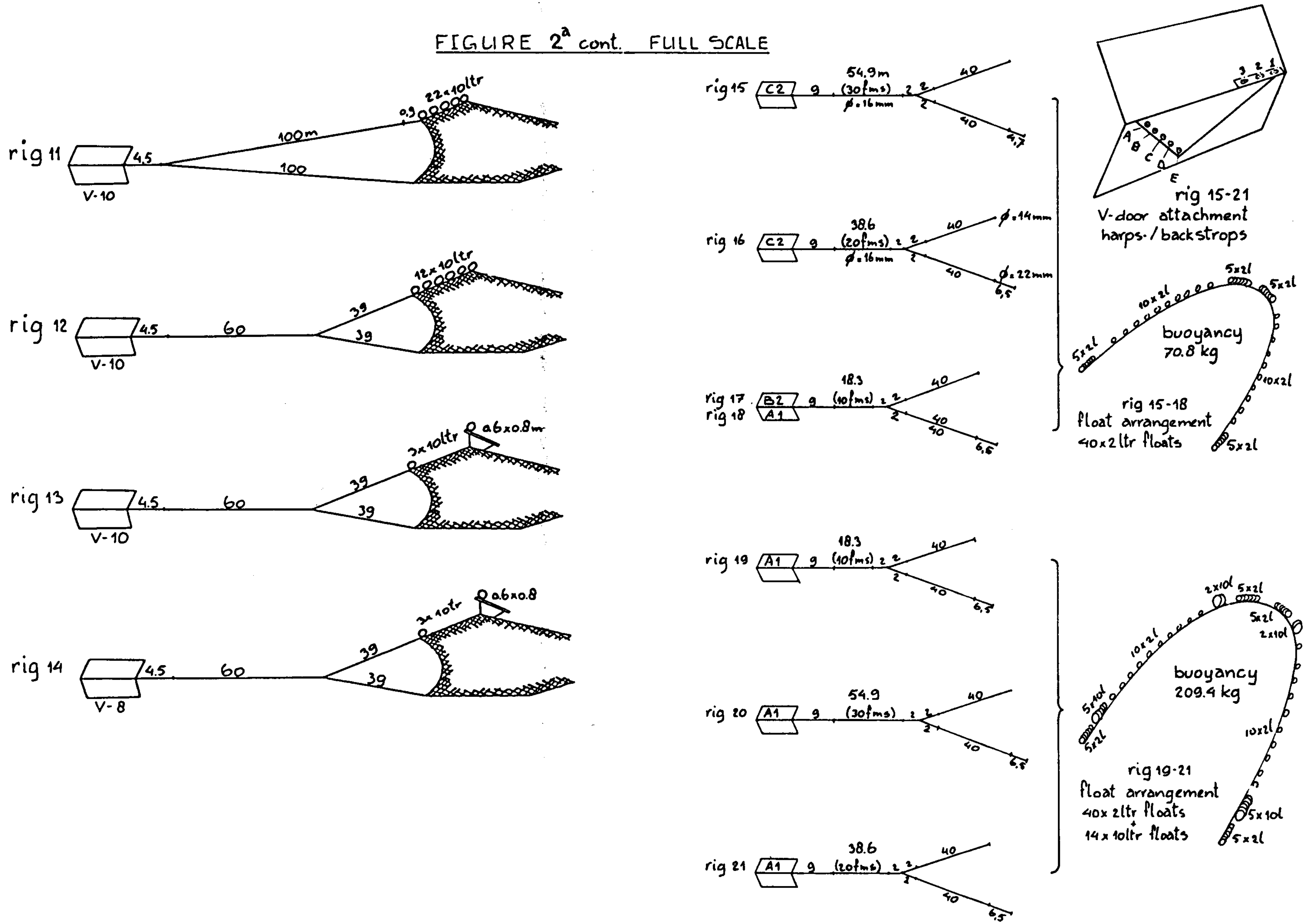
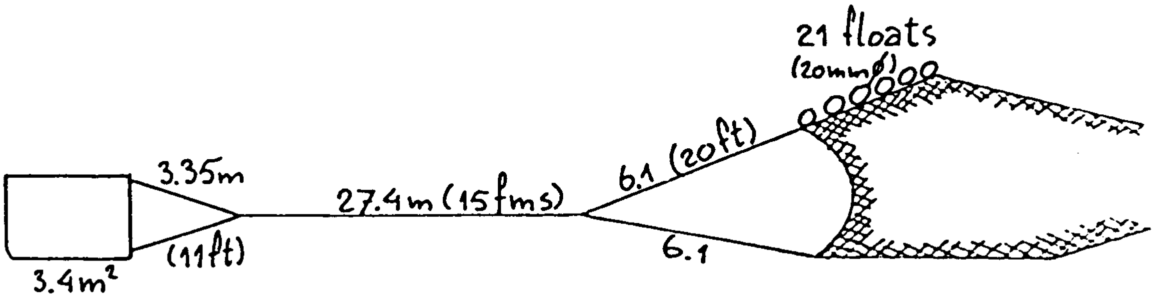
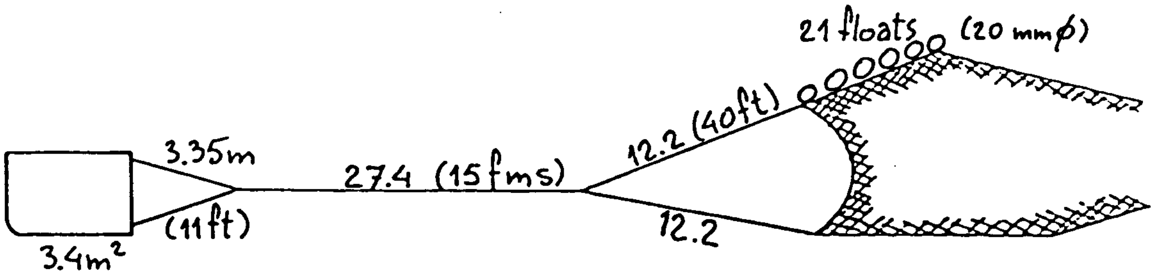


FIGURE 2^b MODEL RIGS

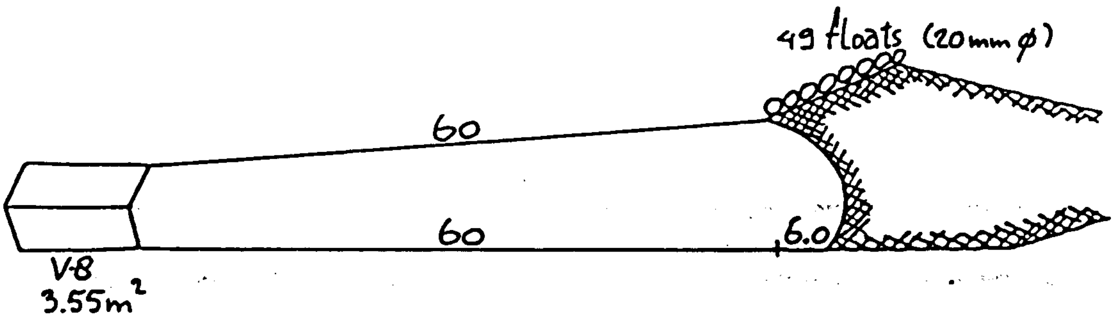
rig 22



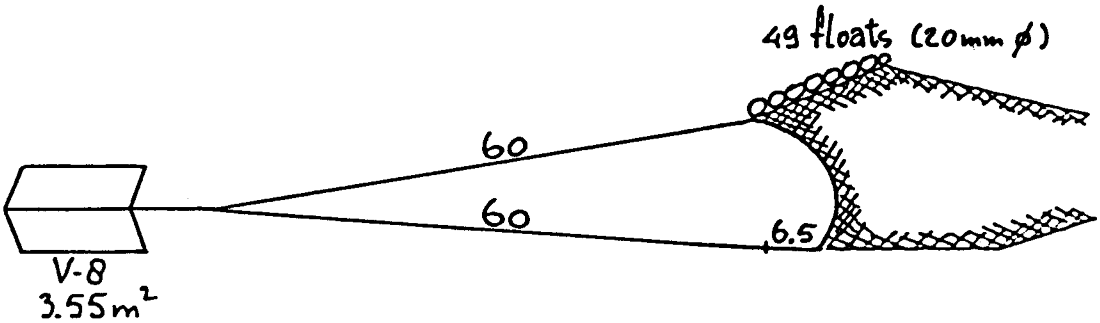
rig 23



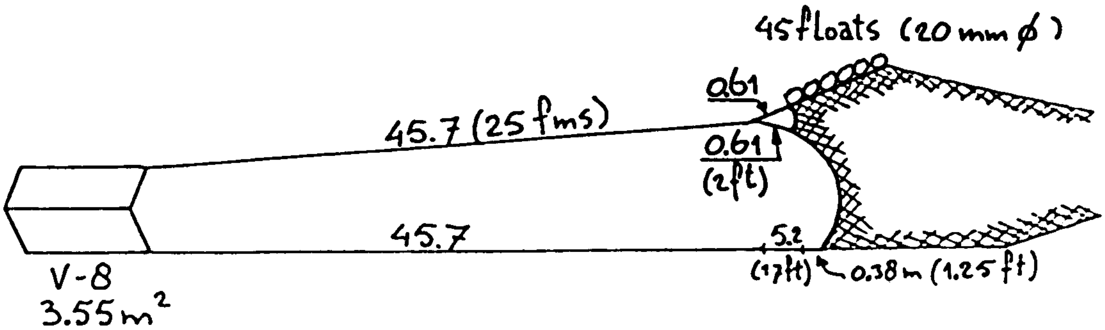
rig 24



rig 25



rig 26



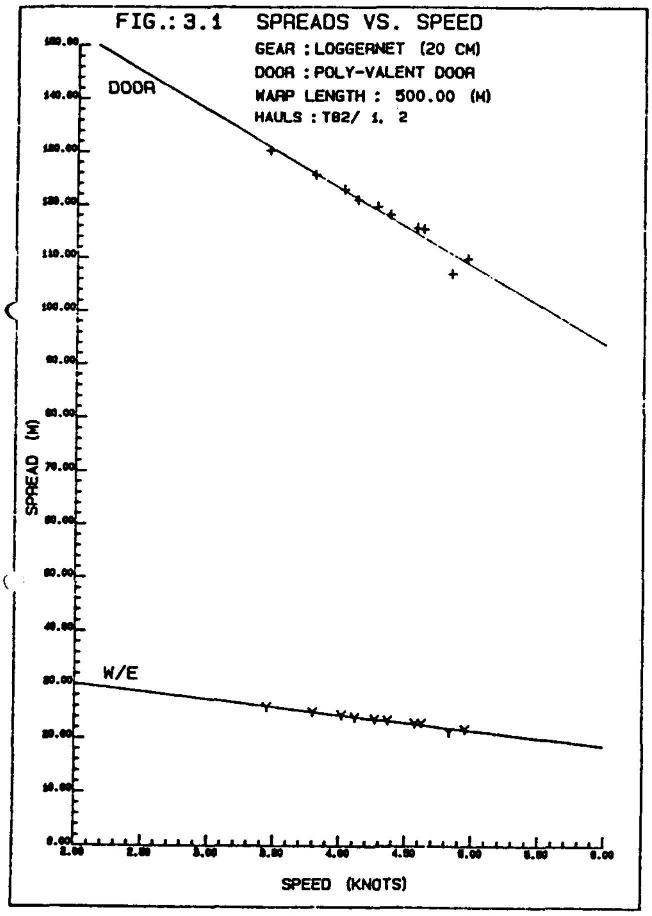


FIG.: 3.1 SPREADS VS. SPEED
GEAR : LOGGERNET (20 CM)
DOOR : POLY-VALENT DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/ 1, 2
DOOR
W/E
SPREAD (M)
SPEED (KNOTS)

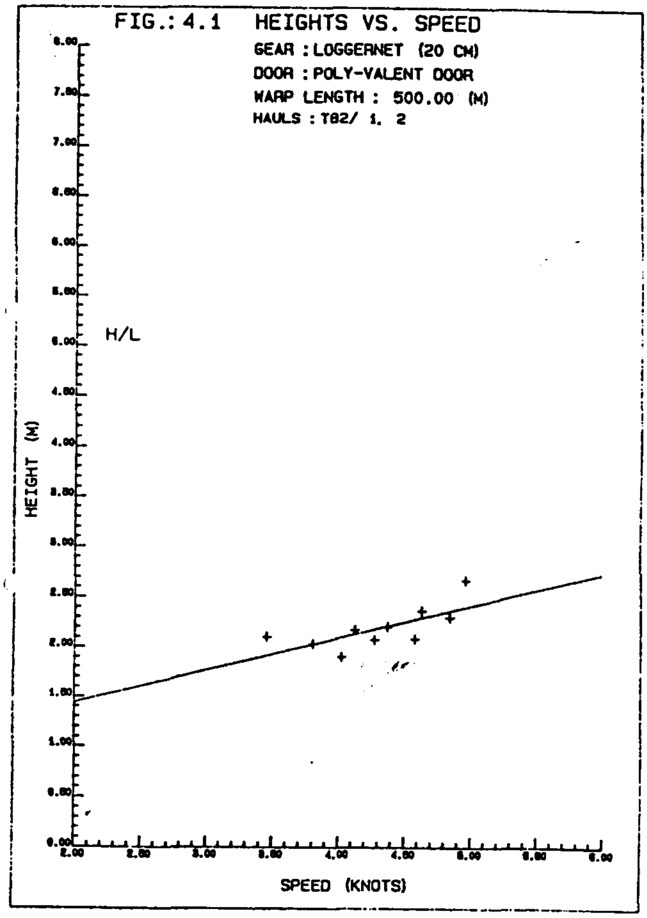


FIG.: 4.1 HEIGHTS VS. SPEED
GEAR : LOGGERNET (20 CM)
DOOR : POLY-VALENT DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/ 1, 2
H/L
HEIGHT (M)
SPEED (KNOTS)

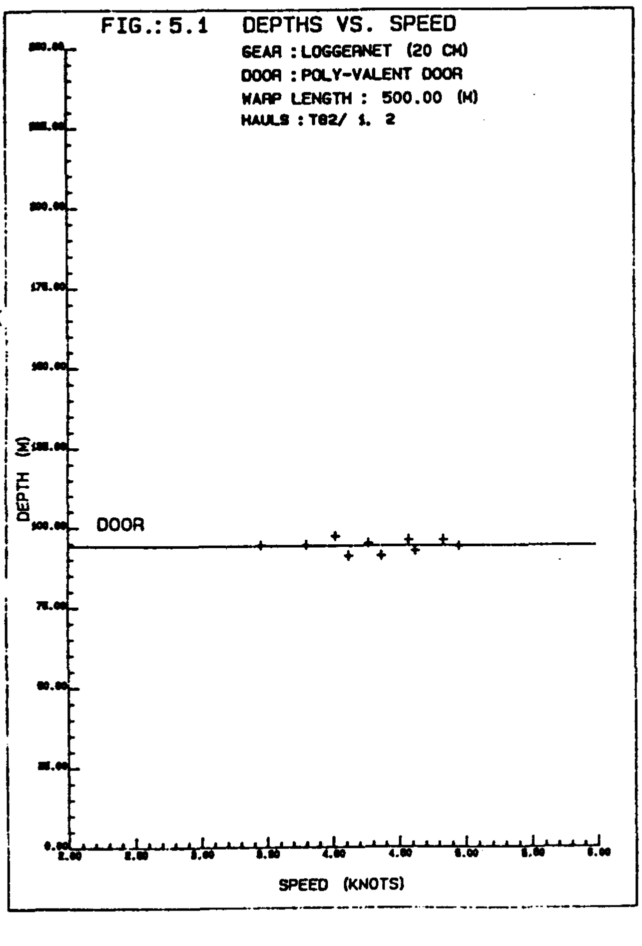


FIG.: 5.1 DEPTHS VS. SPEED
GEAR : LOGGERNET (20 CM)
DOOR : POLY-VALENT DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/ 1, 2
DOOR
DEPTH (M)
SPEED (KNOTS)

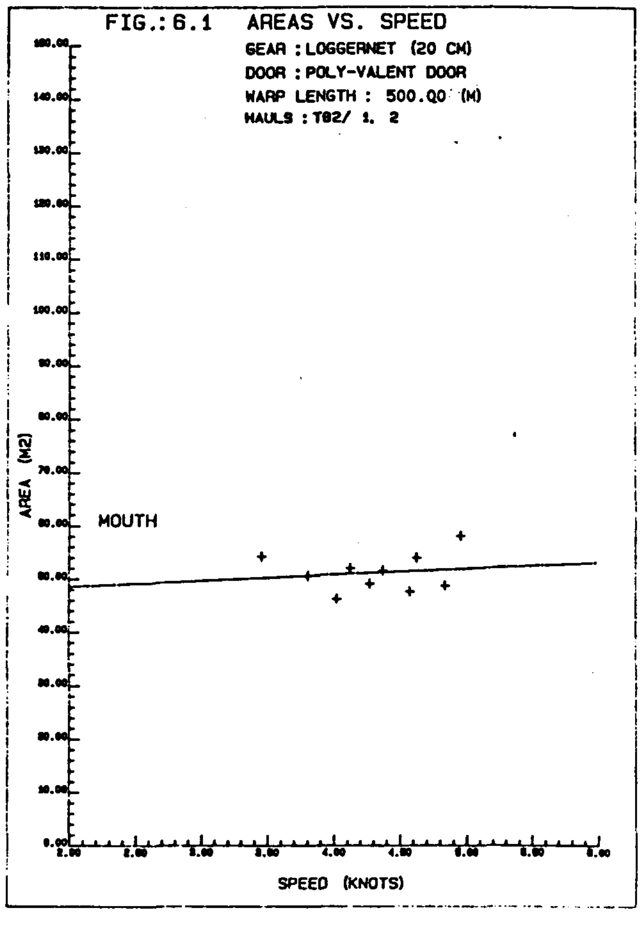


FIG.: 6.1 AREAS VS. SPEED
GEAR : LOGGERNET (20 CM)
DOOR : POLY-VALENT DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/ 1, 2
MOUTH
AREA (M2)
SPEED (KNOTS)

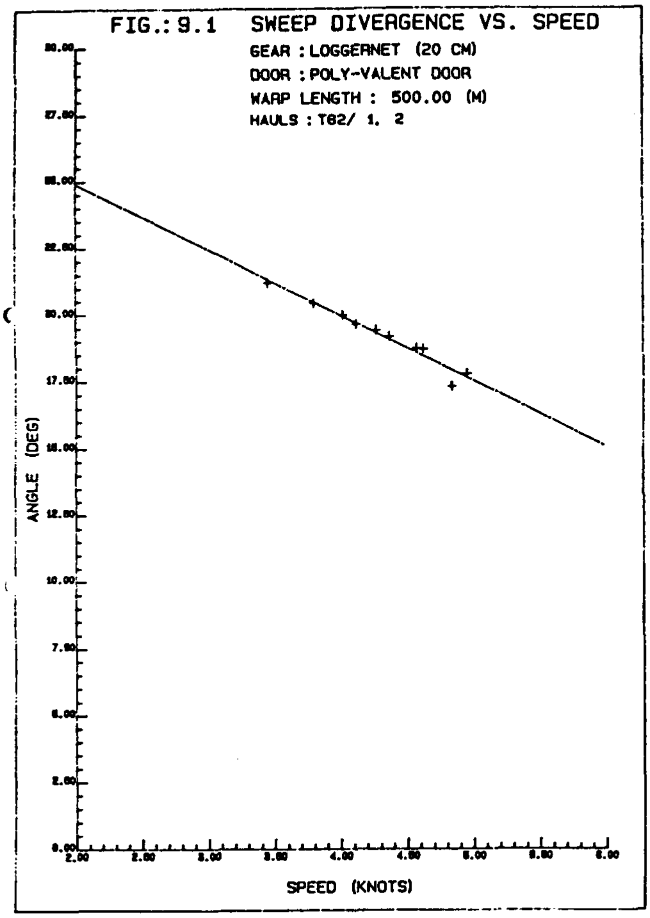


FIG.: 9.1 SWEEP DIVERGENCE VS. SPEED

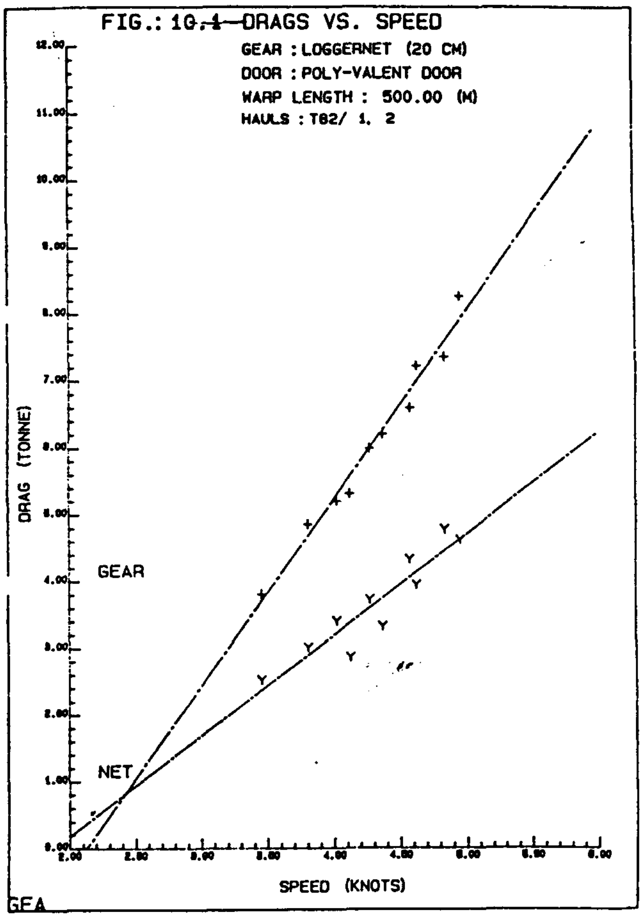


FIG.: 10.1 DRAGS VS. SPEED

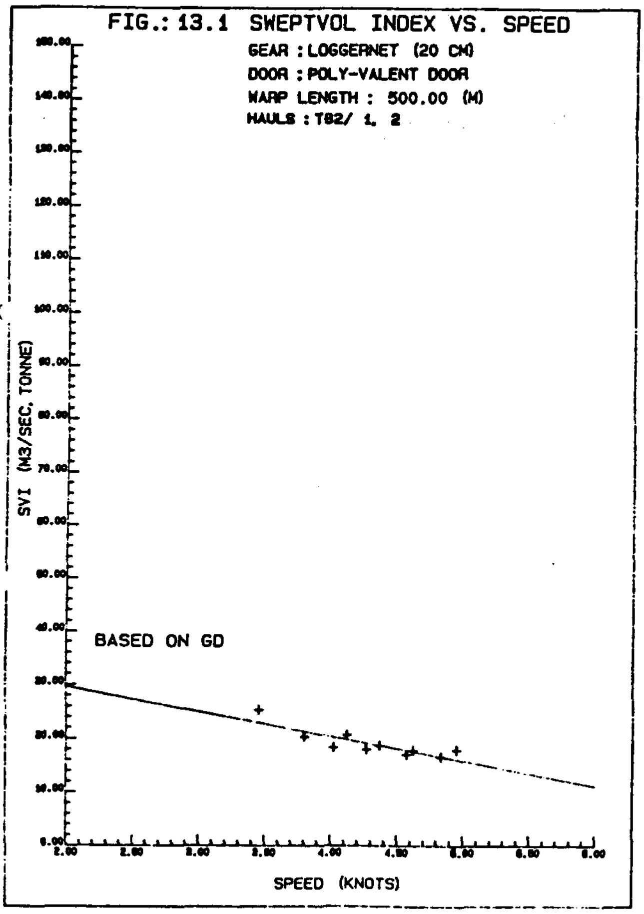


FIG.: 13.1 SWEPTVOL INDEX VS. SPEED

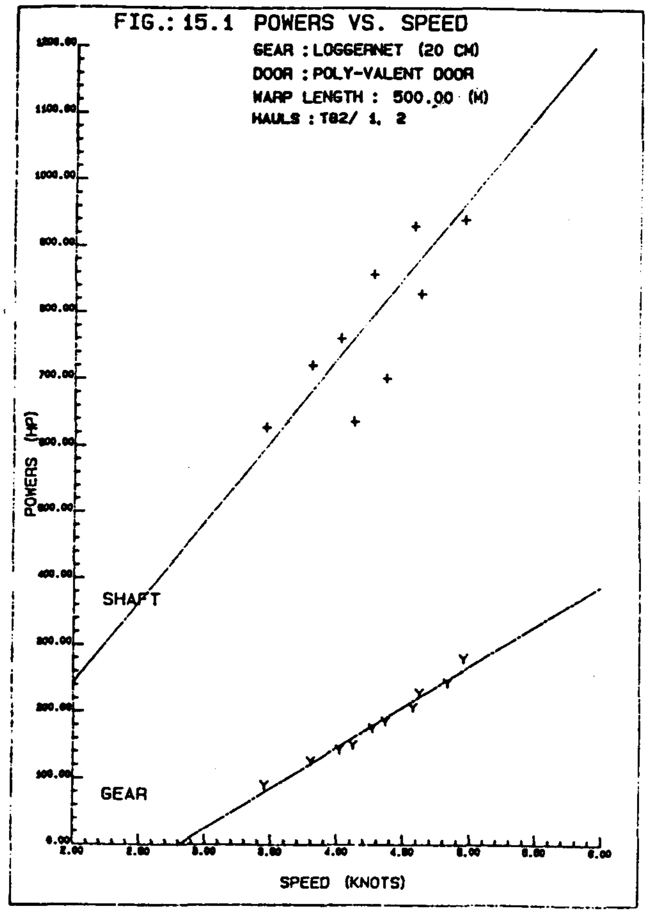


FIG.: 15.1 POWERS VS. SPEED

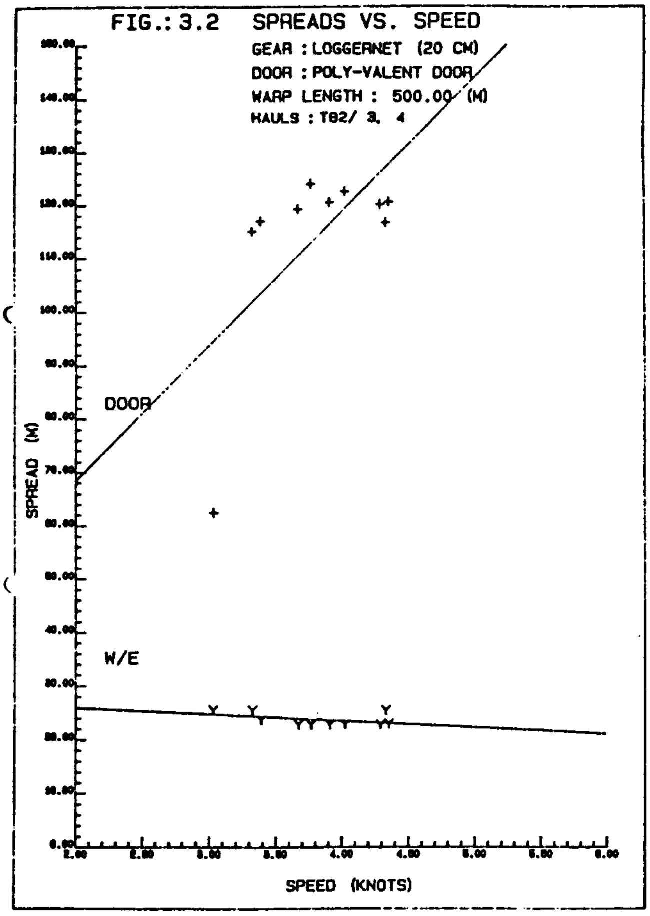


FIG.: 3.2 SPREADS VS. SPEED

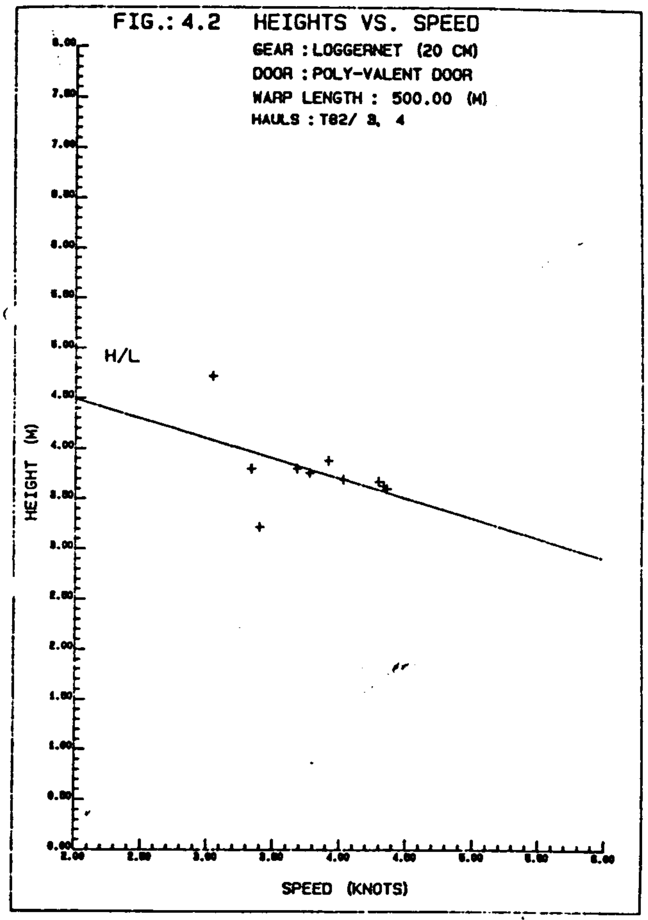


FIG.: 4.2 HEIGHTS VS. SPEED

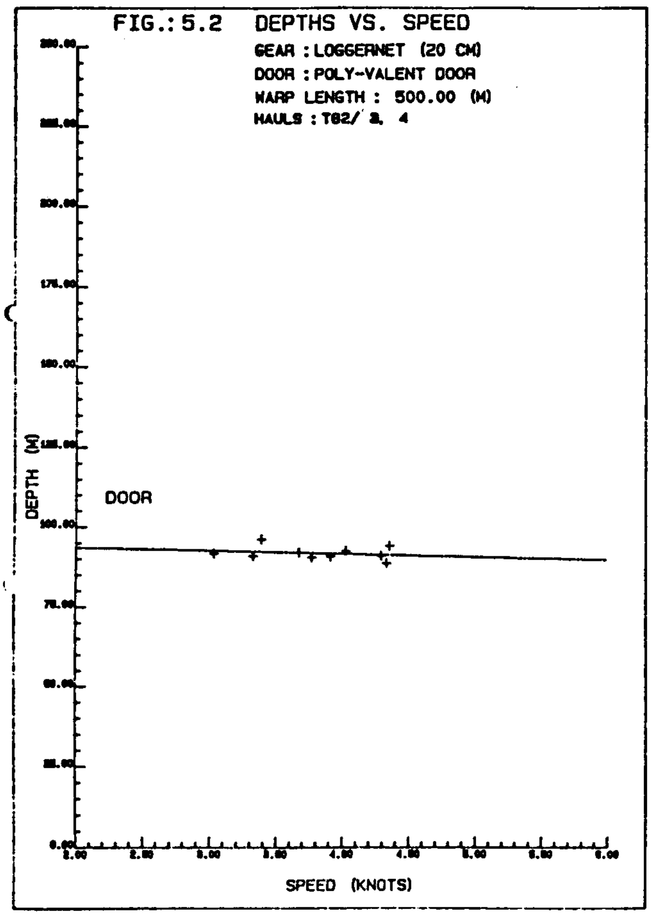


FIG.: 5.2 DEPTHS VS. SPEED

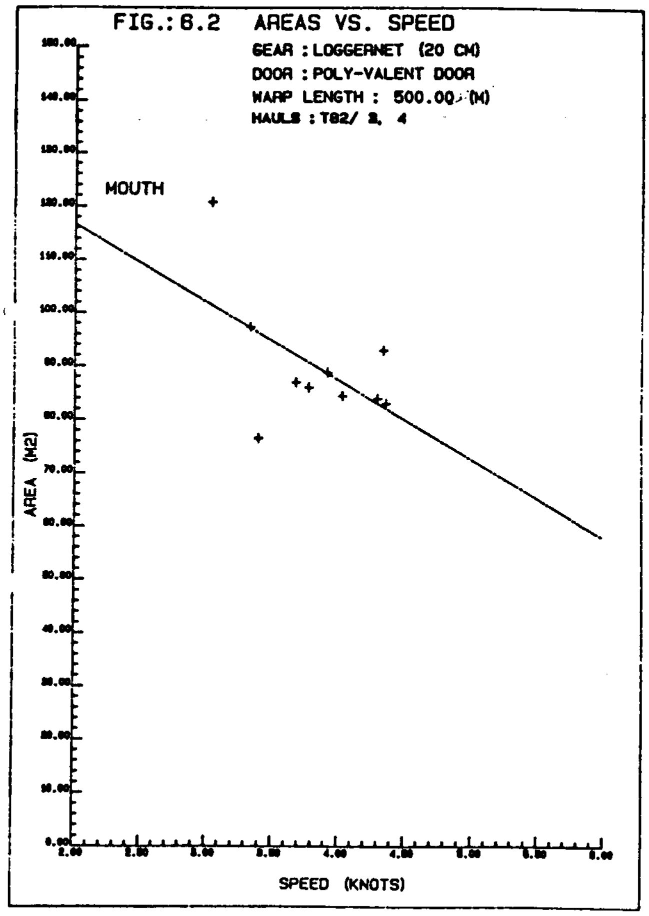


FIG.: 6.2 AREAS VS. SPEED

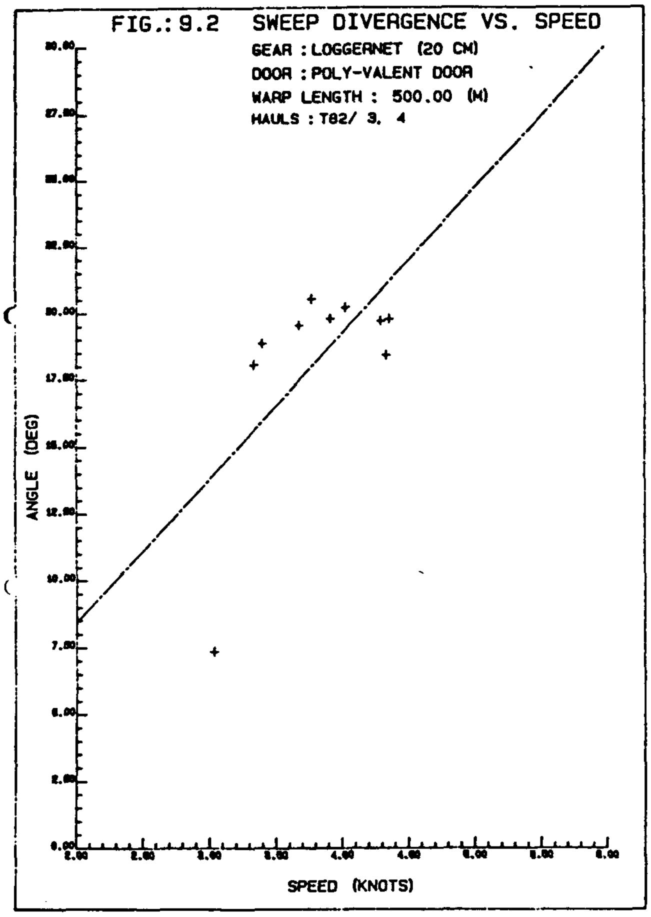


FIG.: 9.2 SWEEP DIVERGENCE VS. SPEED

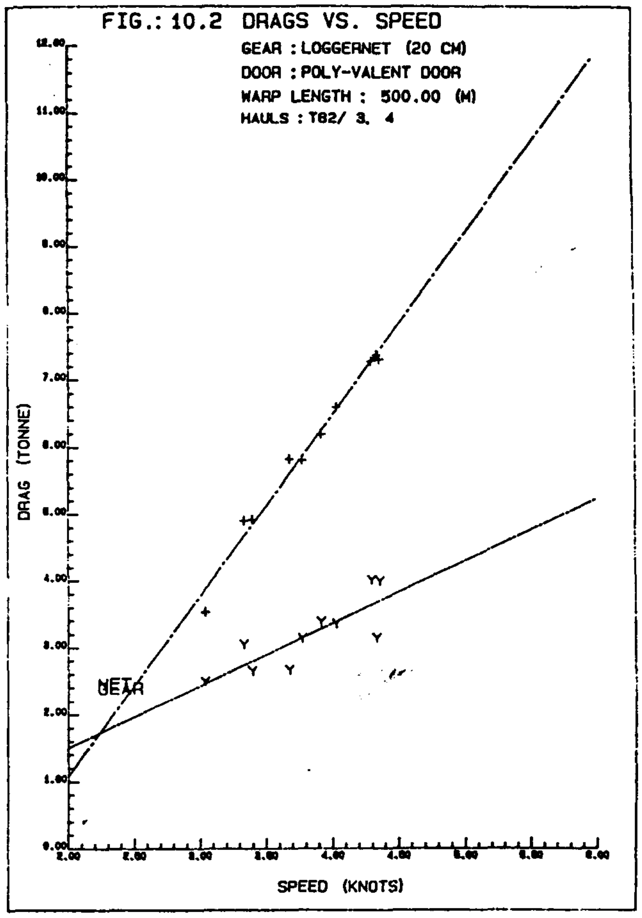


FIG.: 10.2 DRAGS VS. SPEED

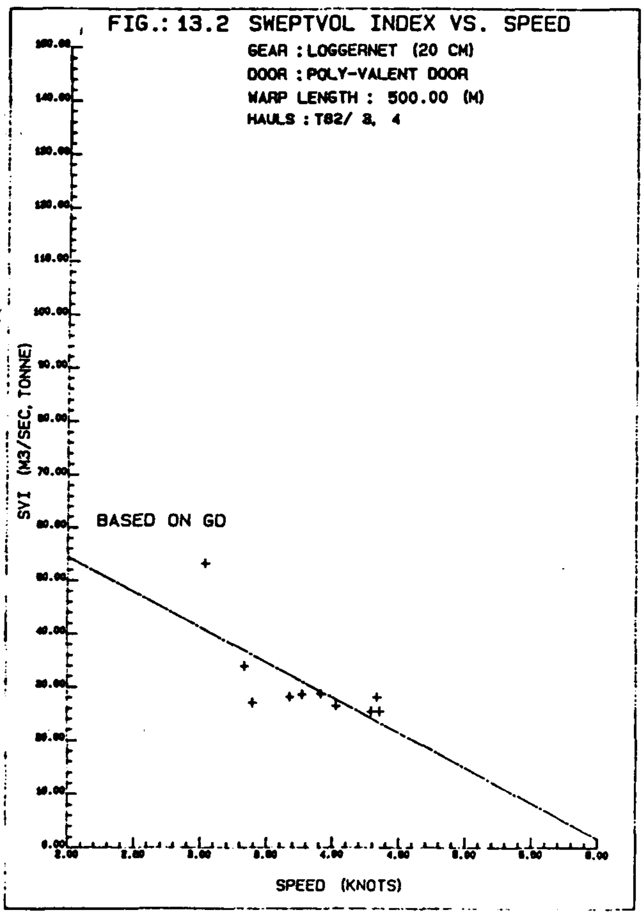


FIG.: 13.2 SWEPTVOL INDEX VS. SPEED

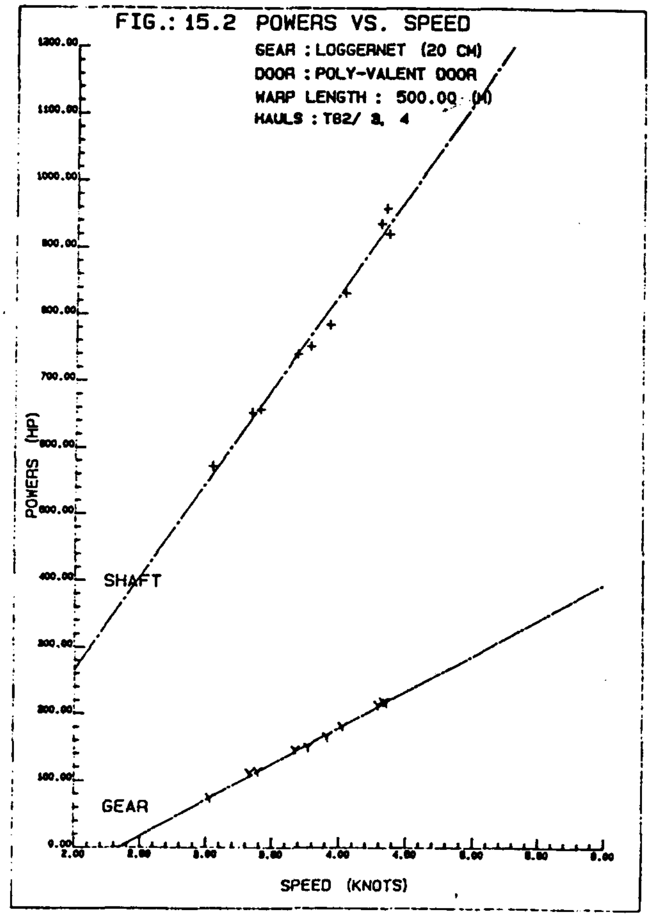


FIG.: 15.2 POWERS VS. SPEED

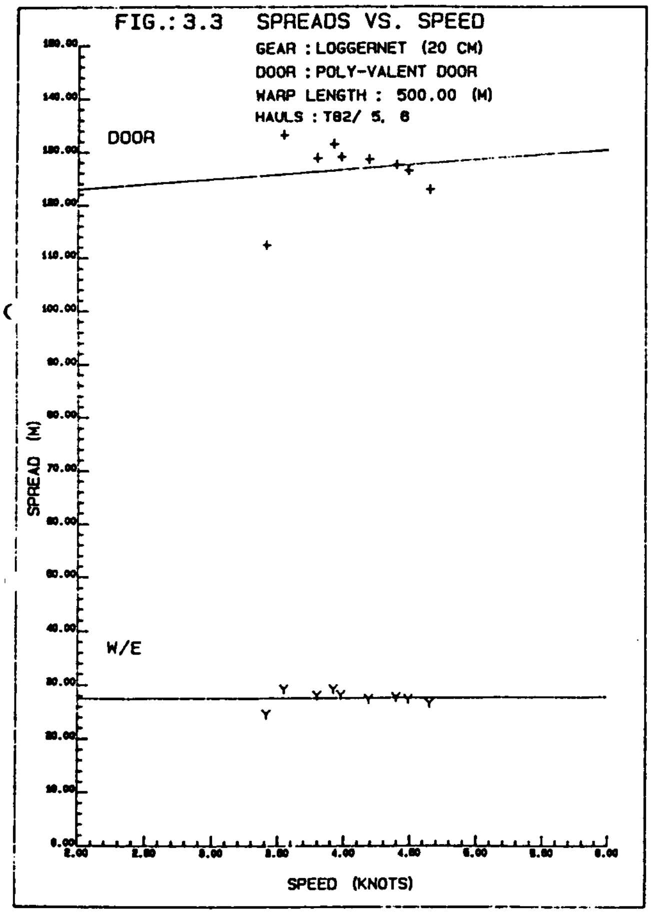


FIG.: 3.3 SPREADS VS. SPEED

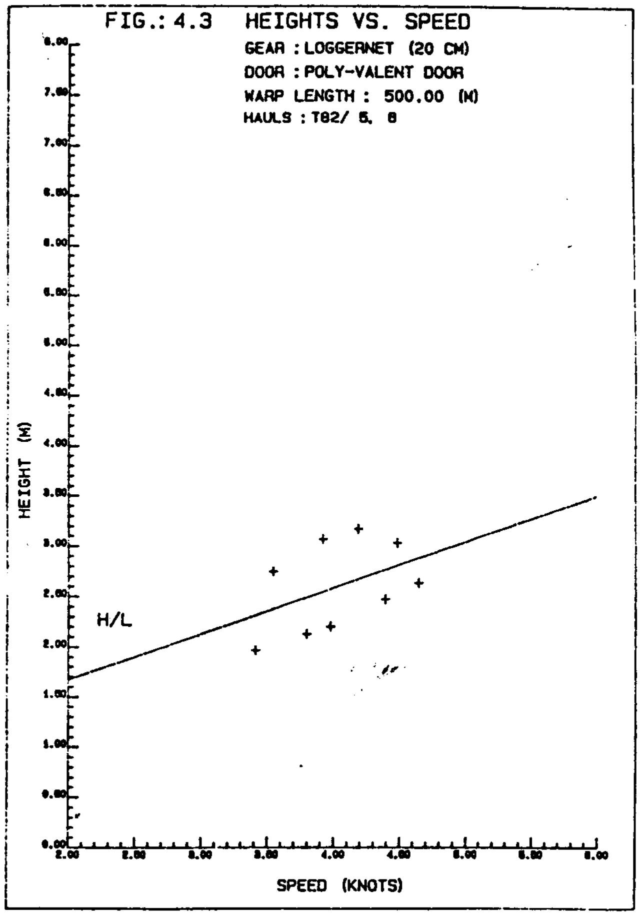


FIG.: 4.3 HEIGHTS VS. SPEED

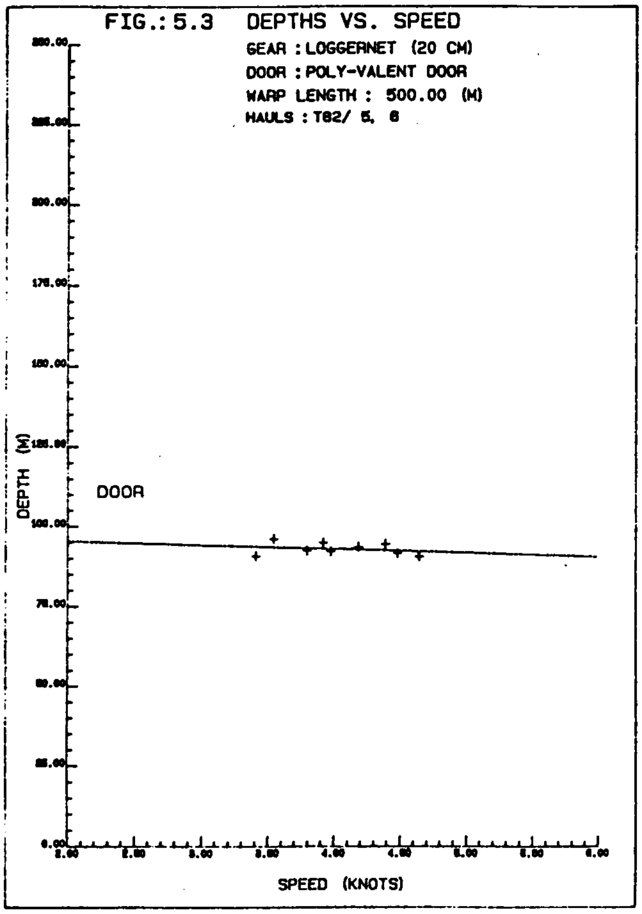


FIG.: 5.3 DEPTHS VS. SPEED

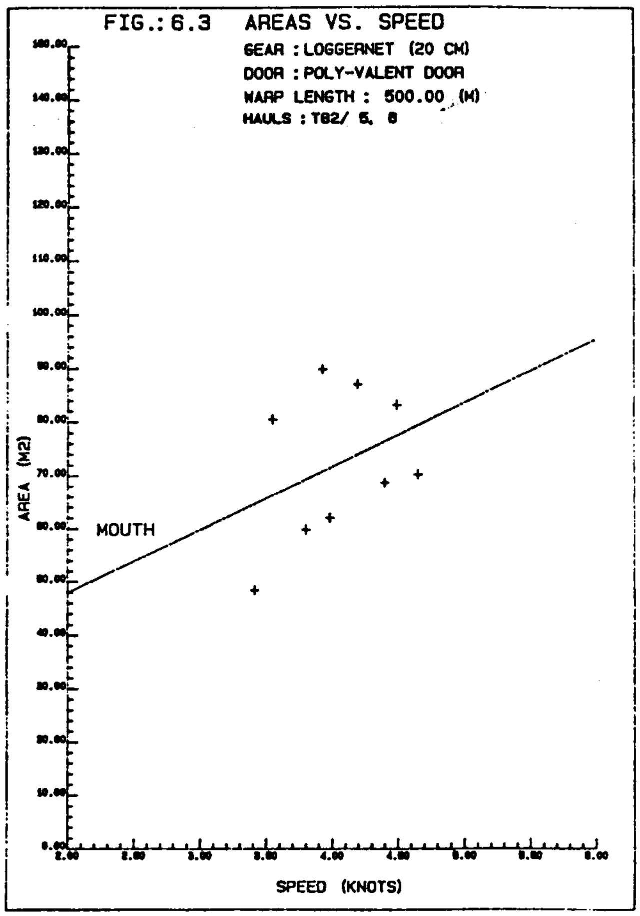


FIG.: 6.3 AREAS VS. SPEED

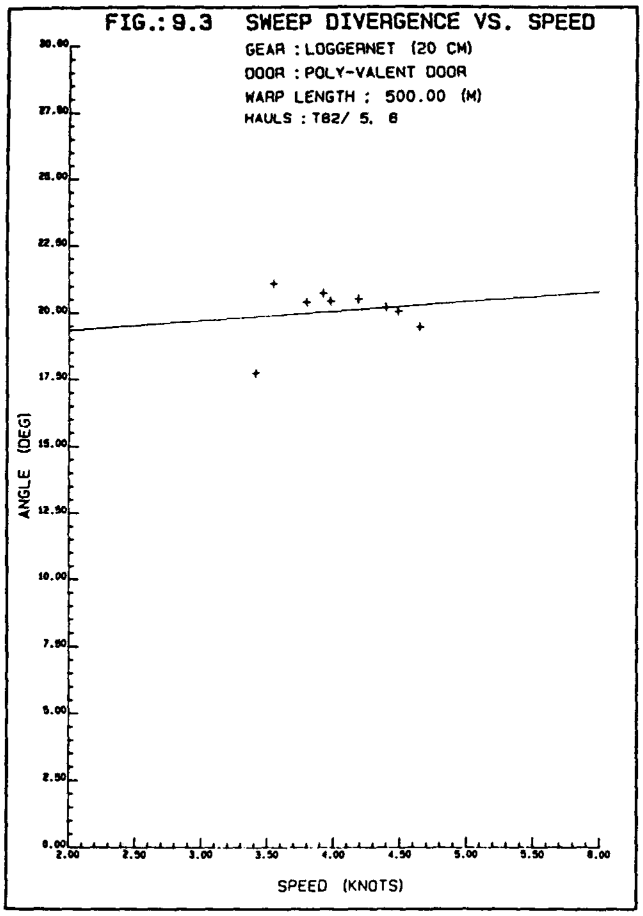


FIG.: 9.3 SWEEP DIVERGENCE VS. SPEED
GEAR : LOGGERNET (20 CM)
DOOR : POLY-VALENT DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/ 5, 6
ANGLE (DEG)
SPEED (KNOTS)

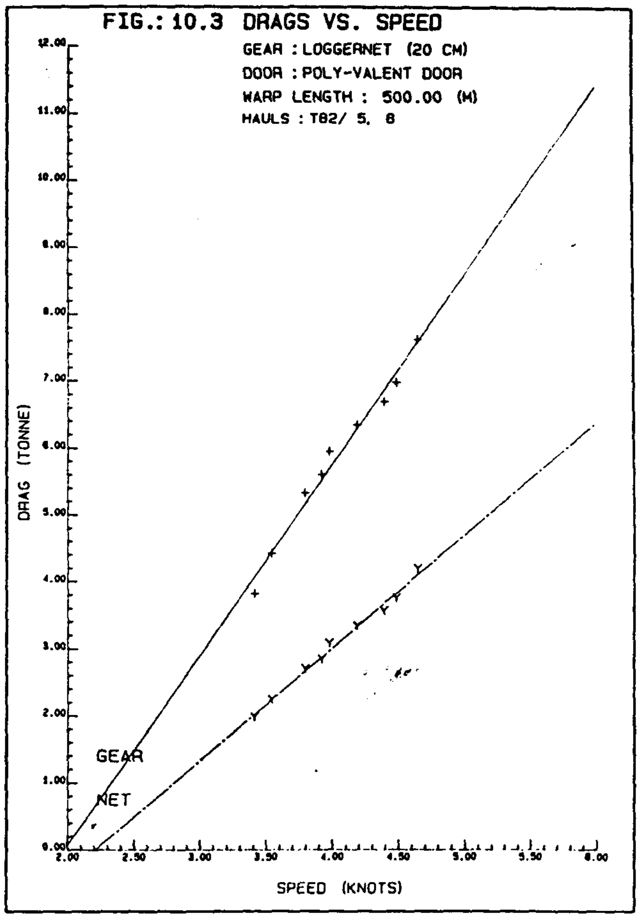


FIG.: 10.3 DRAGS VS. SPEED
GEAR : LOGGERNET (20 CM)
DOOR : POLY-VALENT DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/ 5, 6
DRAG (TONNE)
GEAR
NET
SPEED (KNOTS)

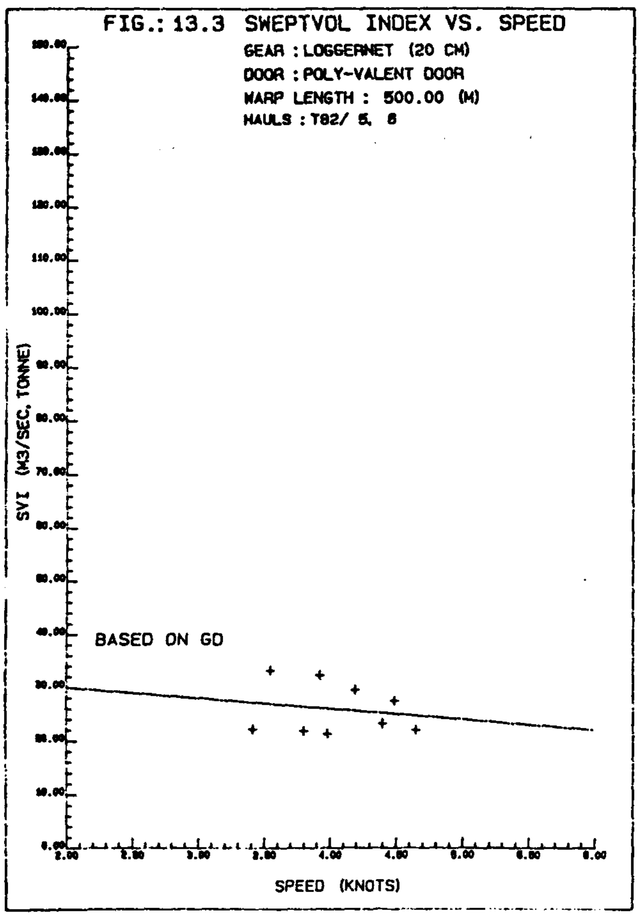


FIG.: 13.3 SWEPTVOL INDEX VS. SPEED
GEAR : LOGGERNET (20 CM)
DOOR : POLY-VALENT DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/ 5, 6
SVI (M3/SEC, TONNE)
BASED ON GD
SPEED (KNOTS)

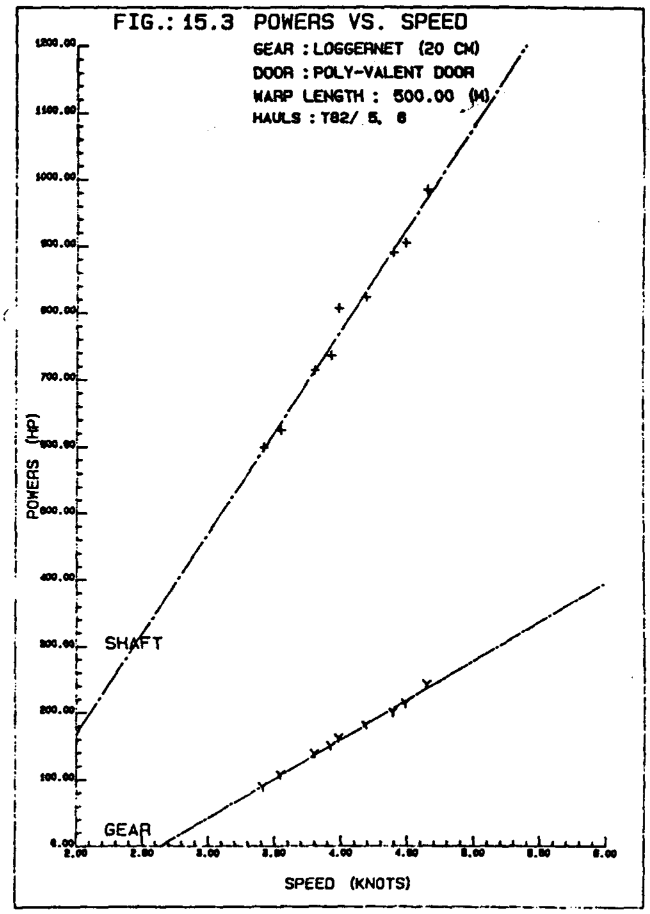


FIG.: 15.3 POWERS VS. SPEED
GEAR : LOGGERNET (20 CM)
DOOR : POLY-VALENT DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/ 5, 6
POWERS (HP)
SHAFT
GEAR
SPEED (KNOTS)

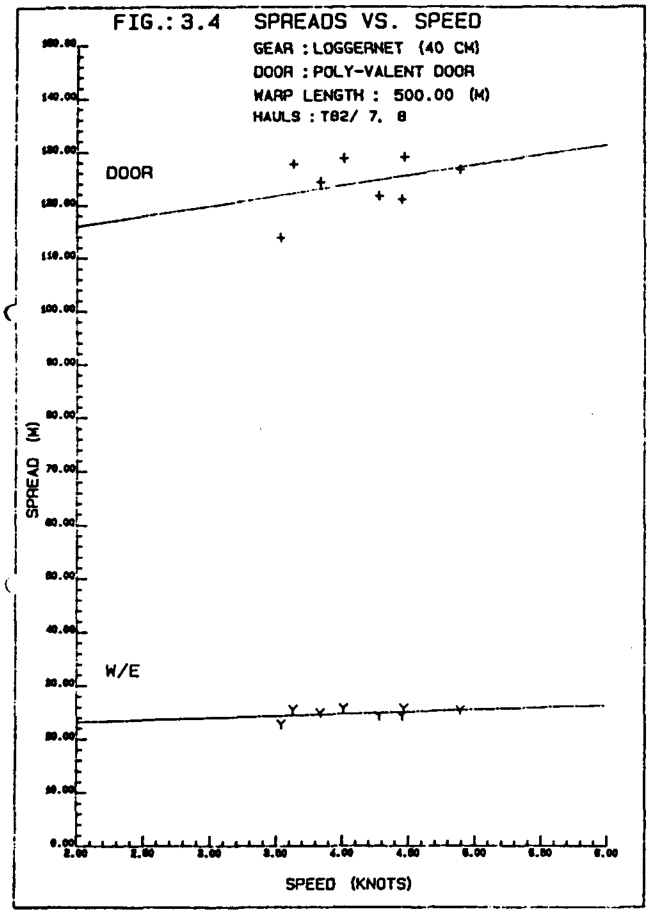


FIG.: 3.4 SPREADS VS. SPEED

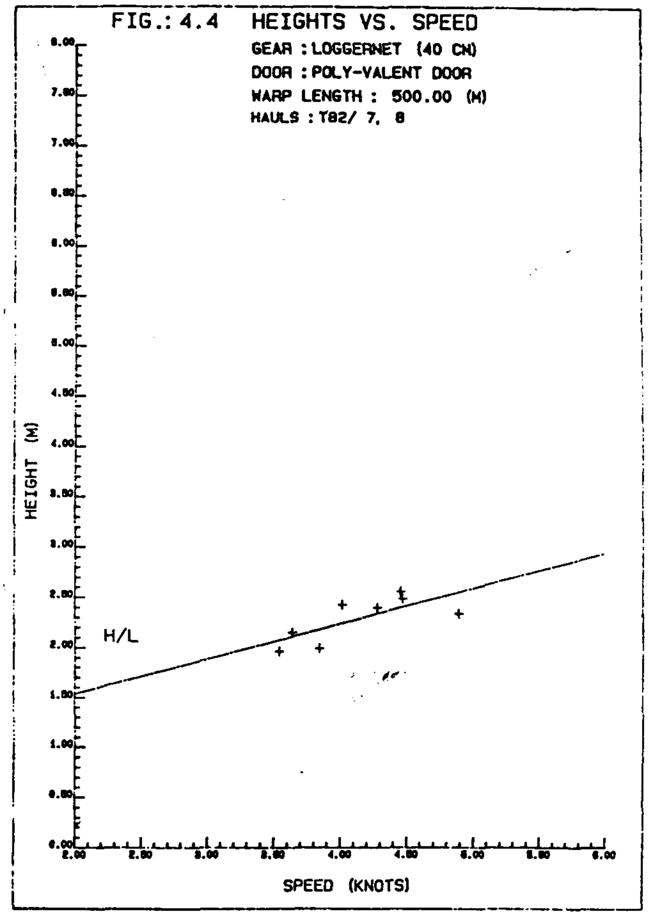


FIG.: 4.4 HEIGHTS VS. SPEED

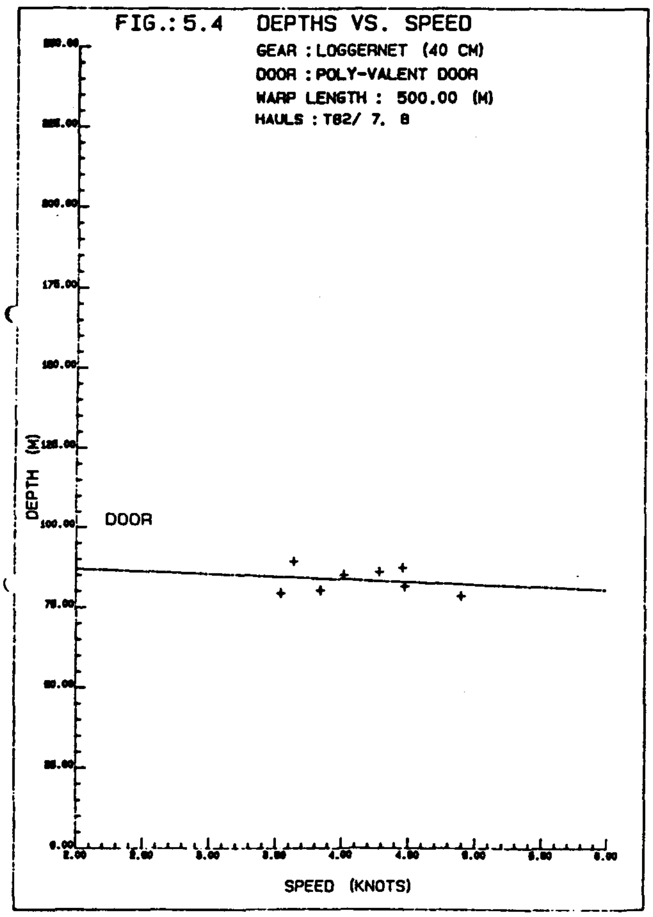


FIG.: 5.4 DEPTHS VS. SPEED

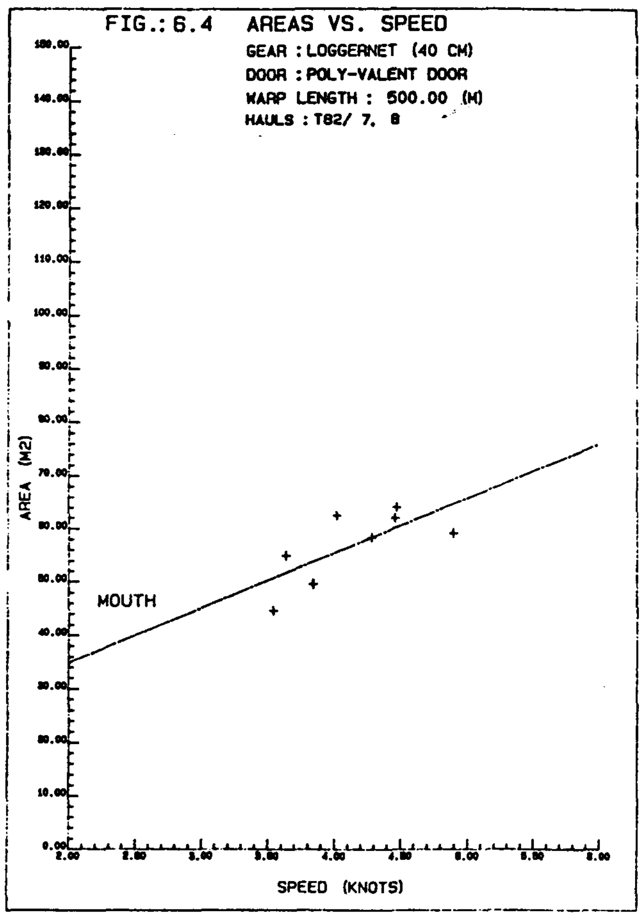


FIG.: 6.4 AREAS VS. SPEED

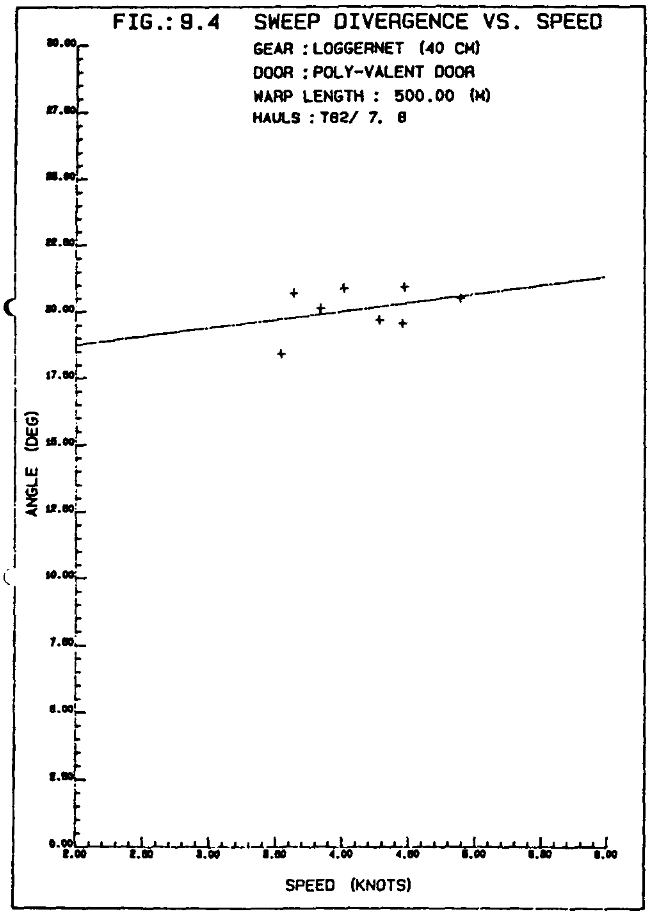


FIG.: 9.4 SWEEP DIVERGENCE VS. SPEED

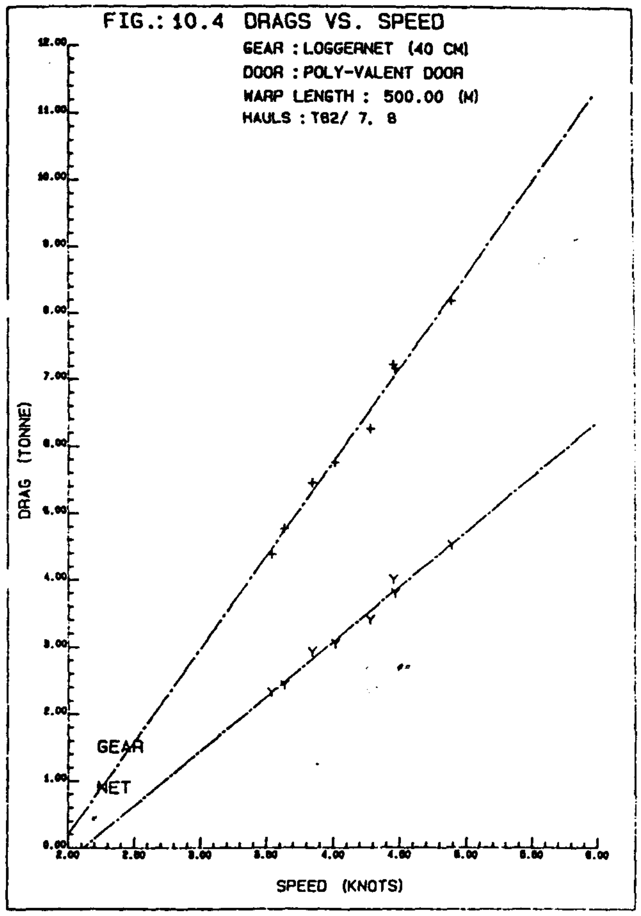


FIG.: 10.4 DRAGS VS. SPEED

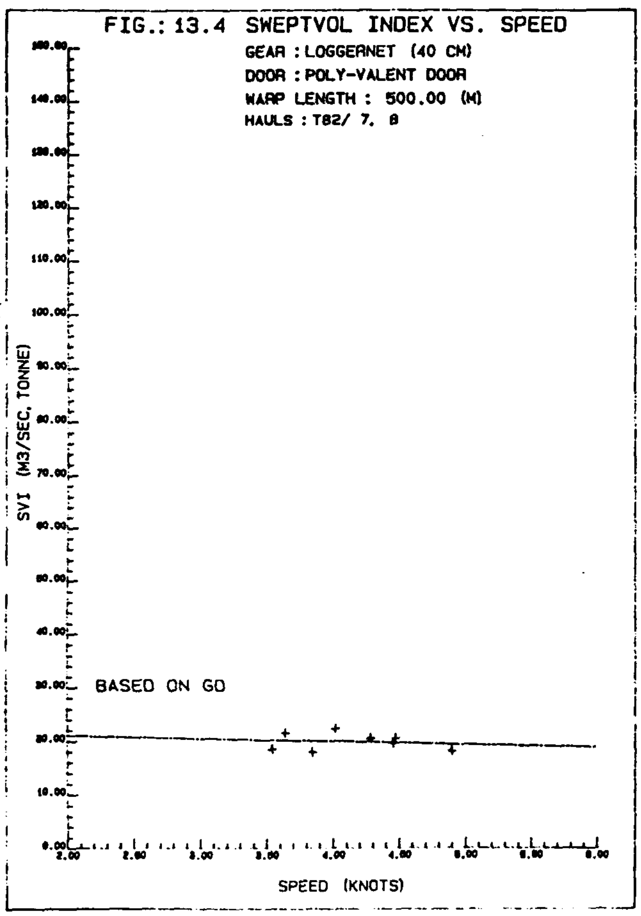


FIG.: 13.4 SWEPTVOL INDEX VS. SPEED

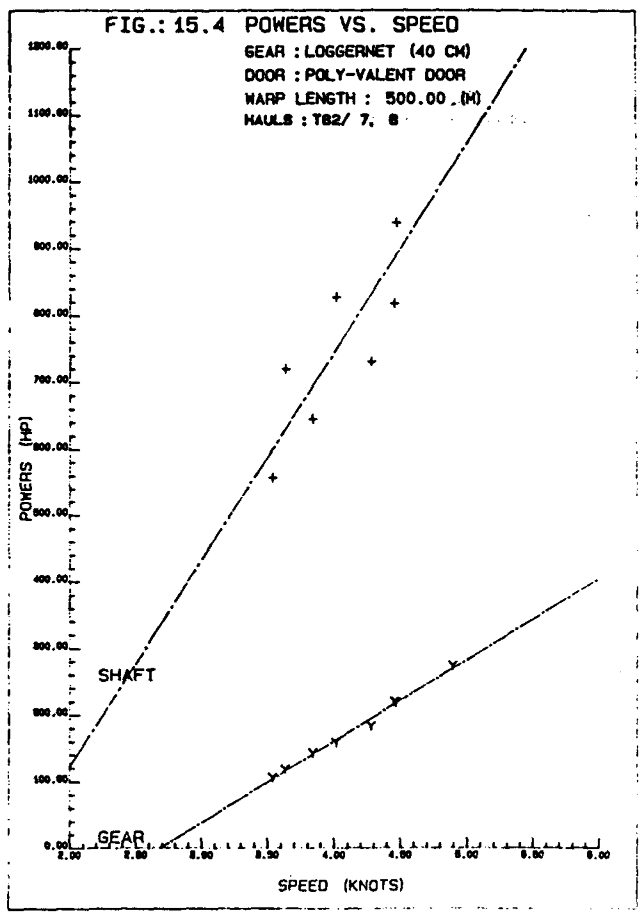


FIG.: 15.4 POWERS VS. SPEED

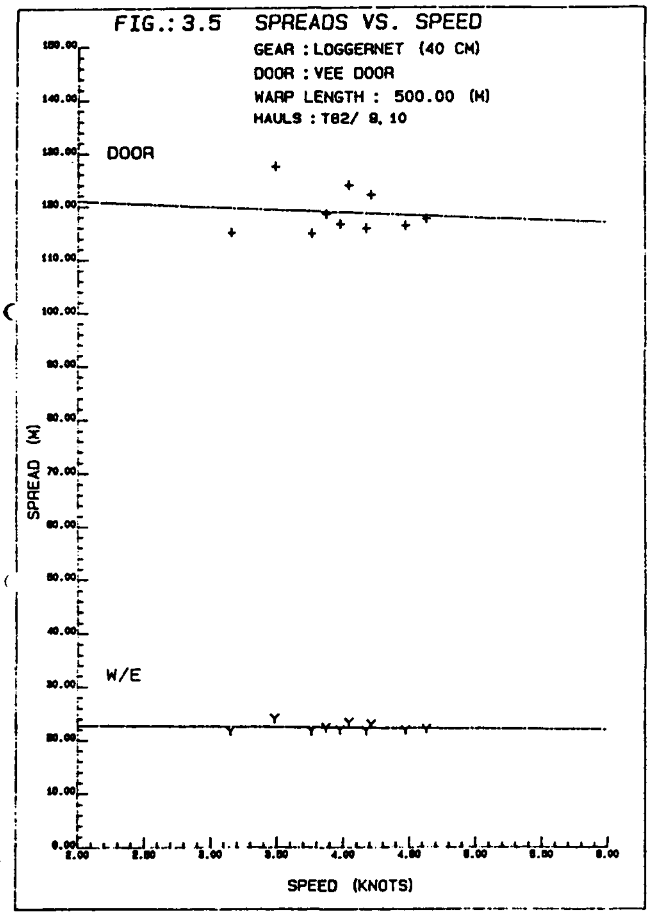


FIG.: 3.5 SPREADS VS. SPEED
GEAR : LOGGERNET (40 CM)
DOOR : VEE DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/ 8, 10
DOOR
W/E
SPREAD (M)
SPEED (KNOTS)

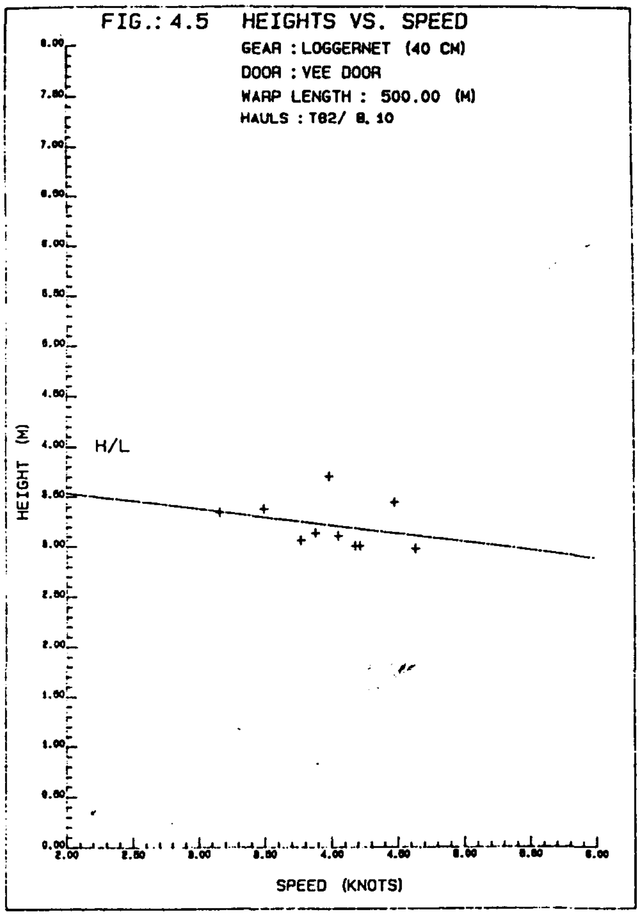


FIG.: 4.5 HEIGHTS VS. SPEED
GEAR : LOGGERNET (40 CM)
DOOR : VEE DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/ 8, 10
H/L
HEIGHT (M)
SPEED (KNOTS)

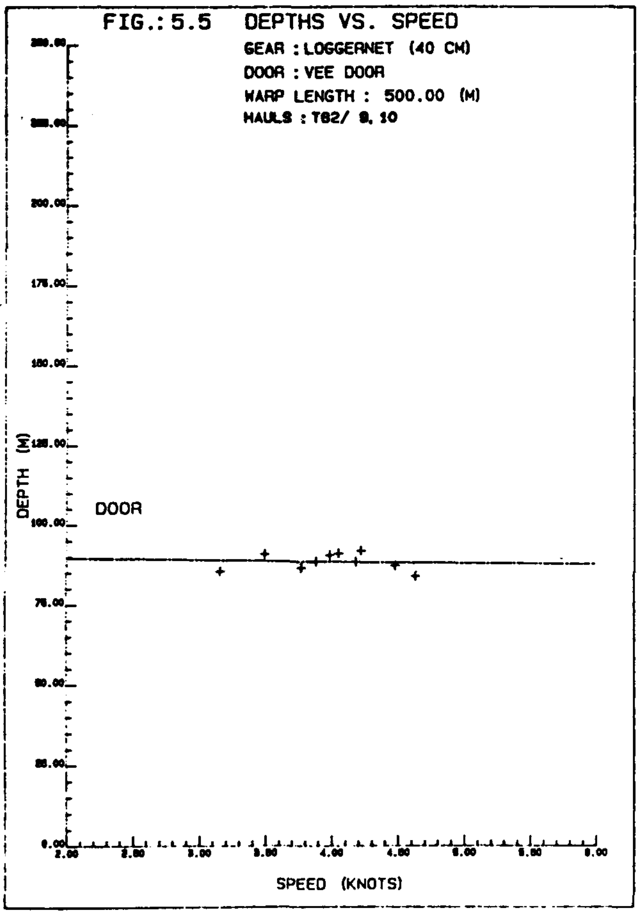


FIG.: 5.5 DEPTHS VS. SPEED
GEAR : LOGGERNET (40 CM)
DOOR : VEE DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/ 8, 10
DOOR
DEPTH (M)
SPEED (KNOTS)

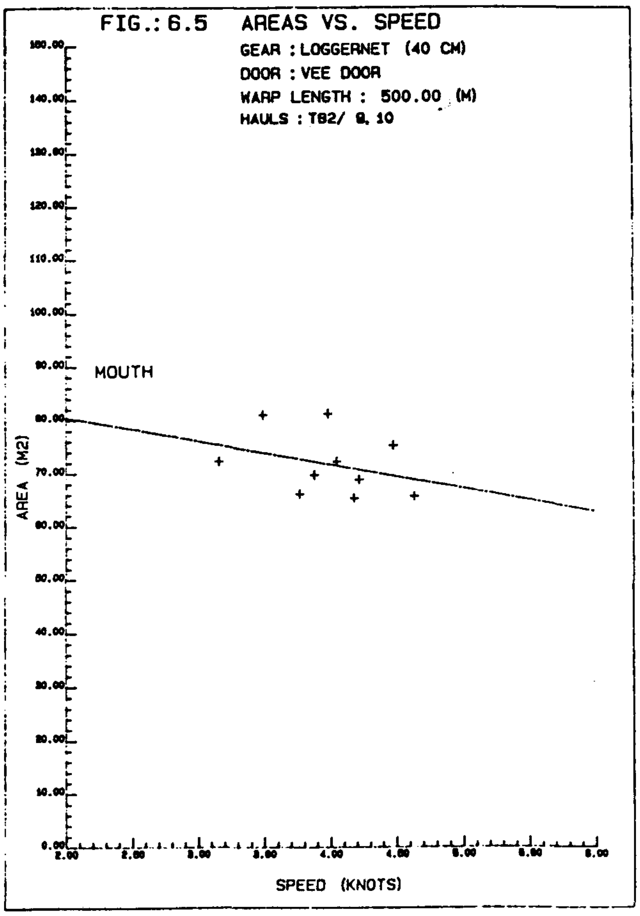


FIG.: 6.5 AREAS VS. SPEED
GEAR : LOGGERNET (40 CM)
DOOR : VEE DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/ 8, 10
MOUTH
AREA (M2)
SPEED (KNOTS)

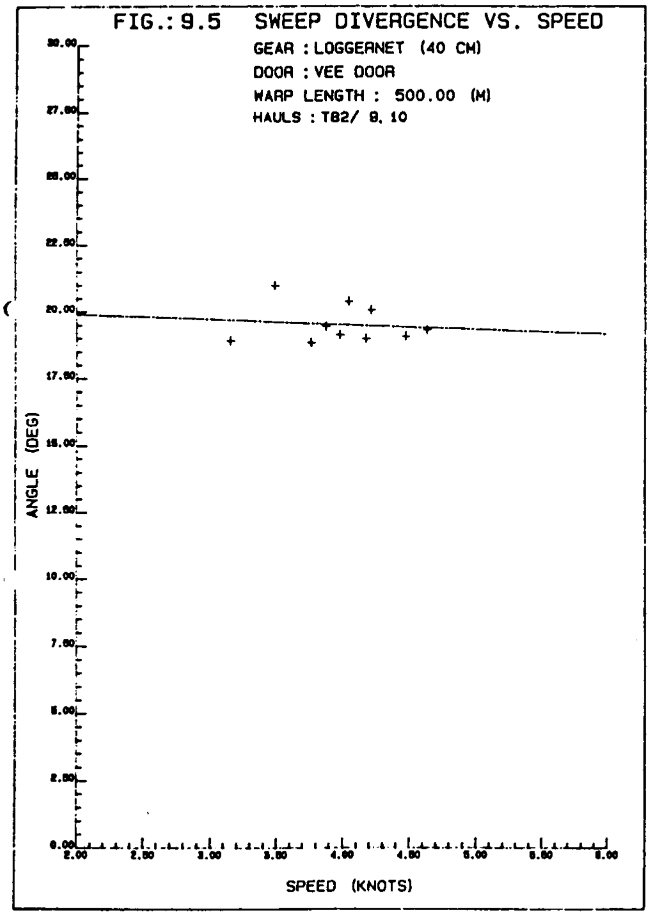


FIG.: 9.5 SWEEP DIVERGENCE VS. SPEED
GEAR : LOGGERNET (40 CM)
DOOR : VEE DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/ 9, 10
ANGLE (DEG)
SPEED (KNOTS)

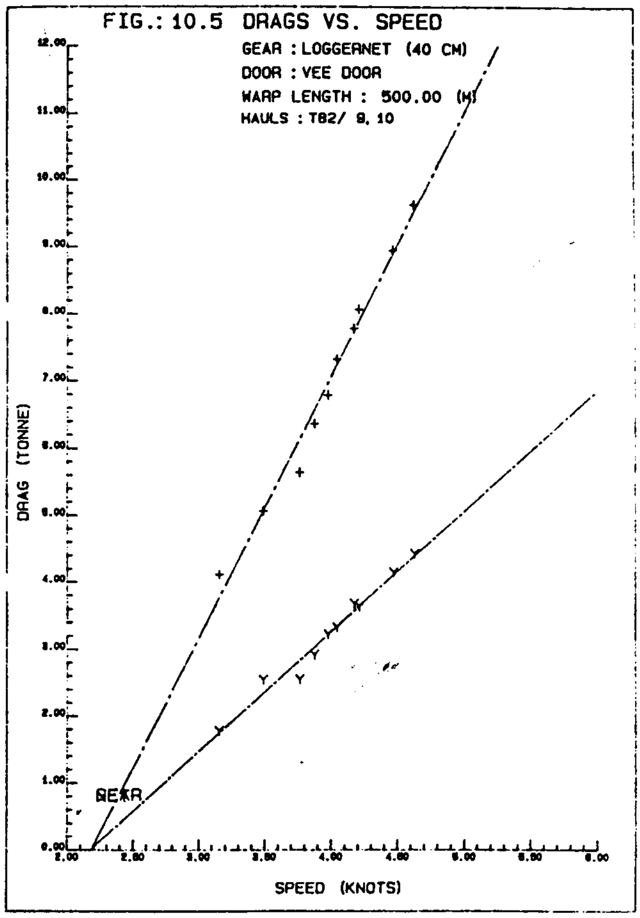


FIG.: 10.5 DRAGS VS. SPEED
GEAR : LOGGERNET (40 CM)
DOOR : VEE DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/ 9, 10
DRAG (TONNE)
GEAR
SPEED (KNOTS)

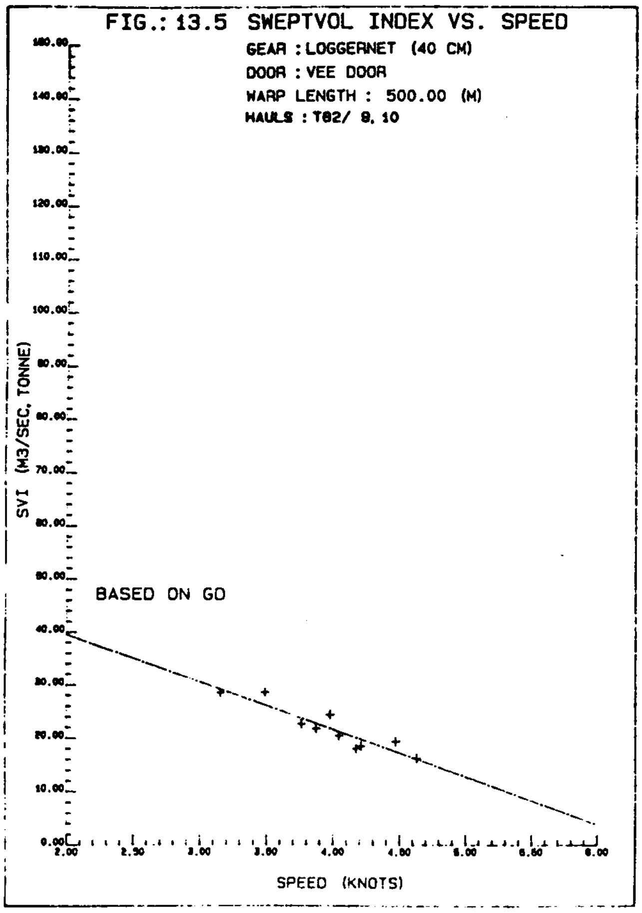


FIG.: 13.5 SWEPTVOL INDEX VS. SPEED
GEAR : LOGGERNET (40 CM)
DOOR : VEE DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/ 9, 10
SVI (M3/SEC, TONNE)
BASED ON GO
SPEED (KNOTS)

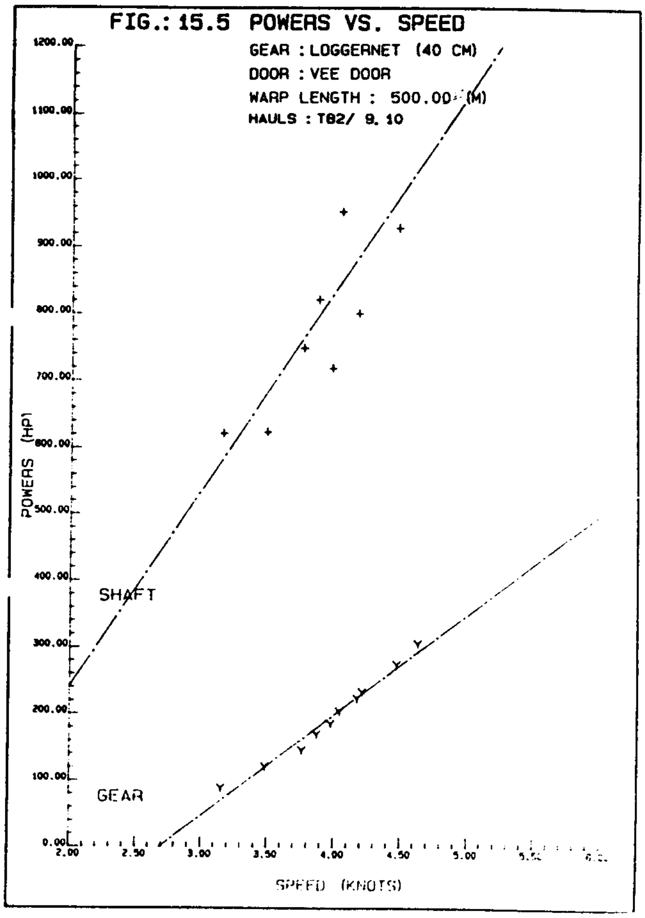


FIG.: 15.5 POWERS VS. SPEED
GEAR : LOGGERNET (40 CM)
DOOR : VEE DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/ 9, 10
POWERS (HP)
SHAFT
GEAR
SPEED (KNOTS)

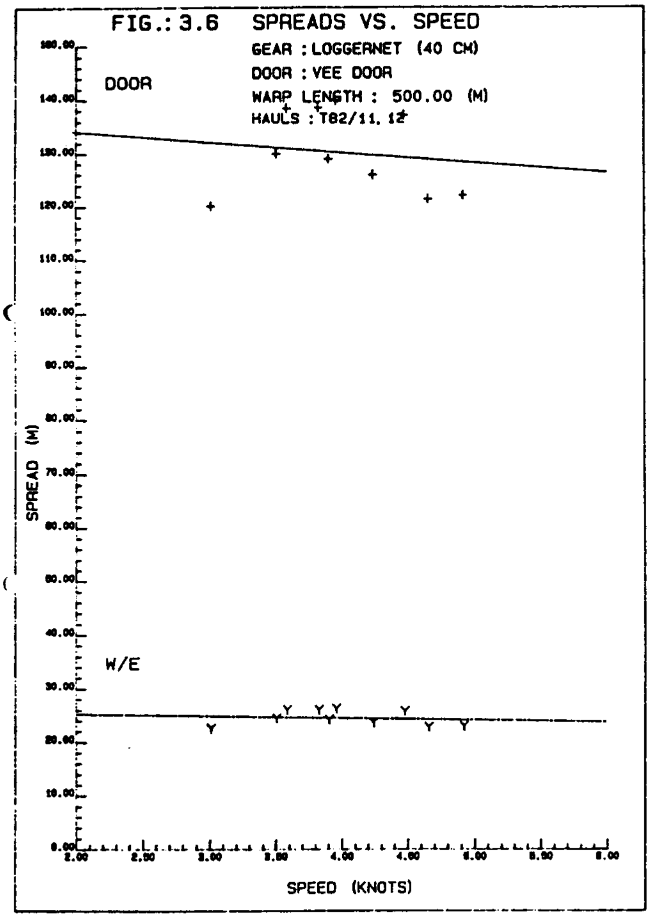


FIG.: 3.6 SPREADS VS. SPEED
GEAR : LOGGERNET (40 CM)
DOOR : VEE DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/11, 12
DOOR
W/E
SPREAD (M)
SPEED (KNOTS)

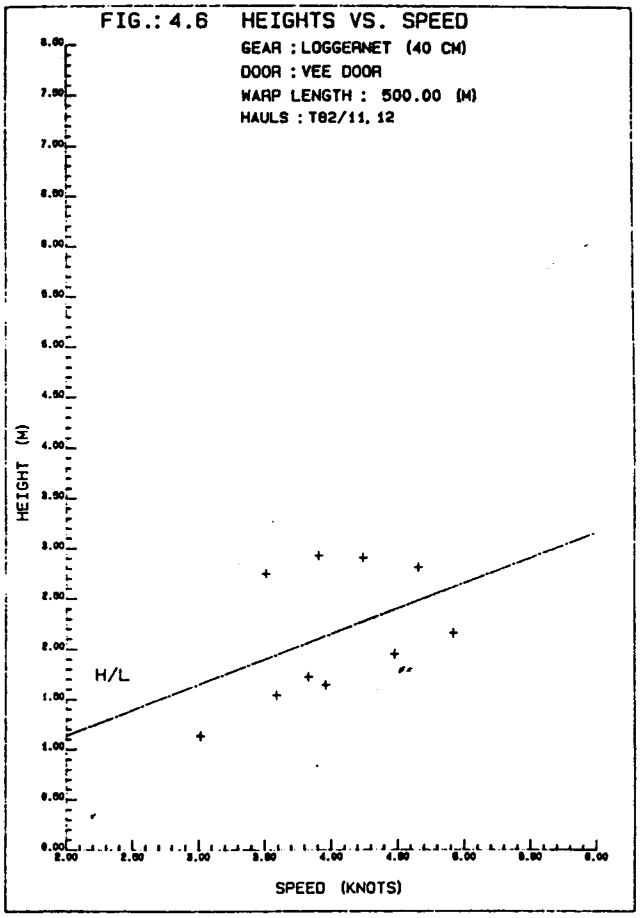


FIG.: 4.6 HEIGHTS VS. SPEED
GEAR : LOGGERNET (40 CM)
DOOR : VEE DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/11, 12
H/L
HEIGHT (M)
SPEED (KNOTS)

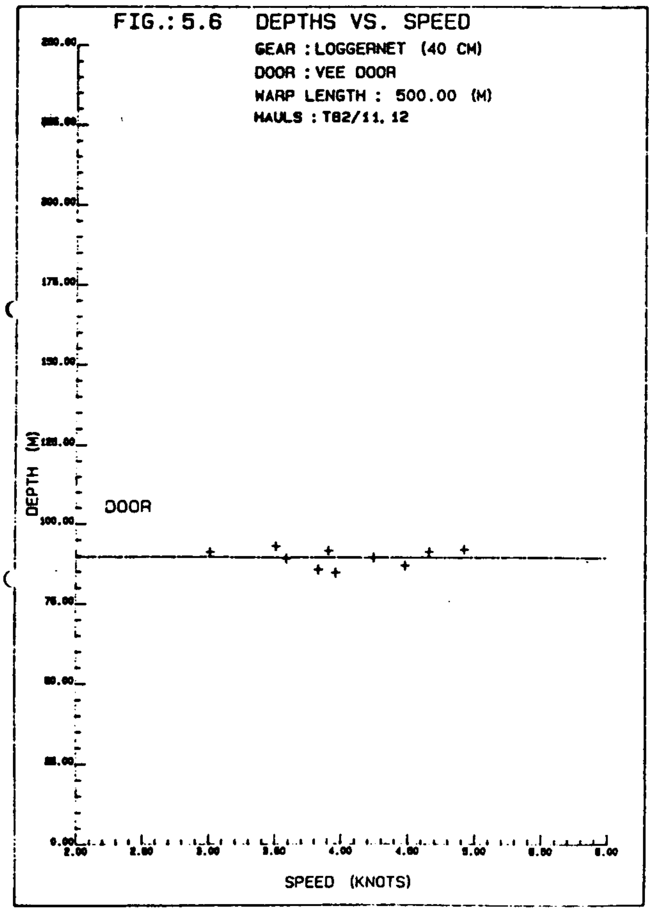


FIG.: 5.6 DEPTHS VS. SPEED
GEAR : LOGGERNET (40 CM)
DOOR : VEE DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/11, 12
DOOR
DEPTH (M)
SPEED (KNOTS)

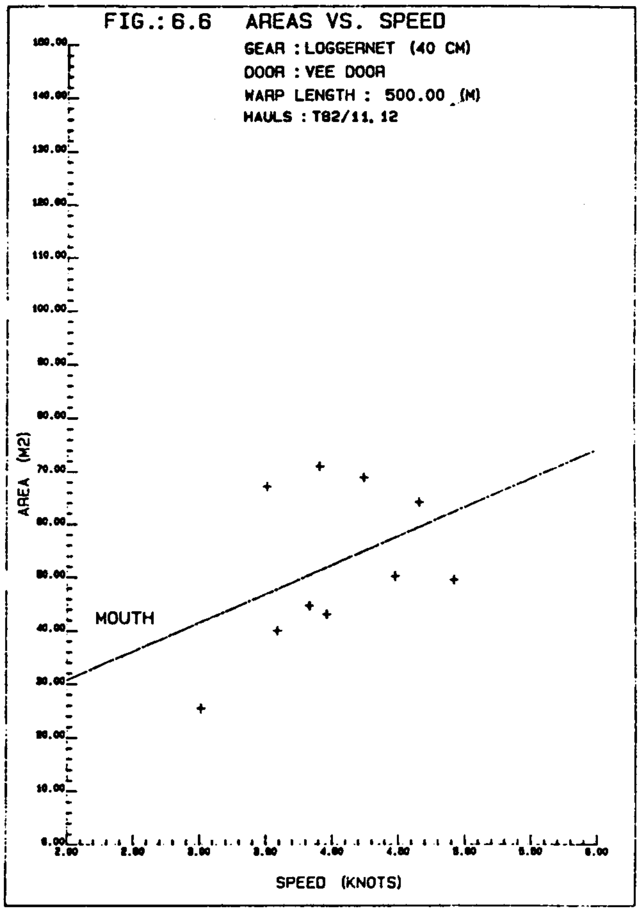


FIG.: 6.6 AREAS VS. SPEED
GEAR : LOGGERNET (40 CM)
DOOR : VEE DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/11, 12
MOUTH
AREA (M2)
SPEED (KNOTS)

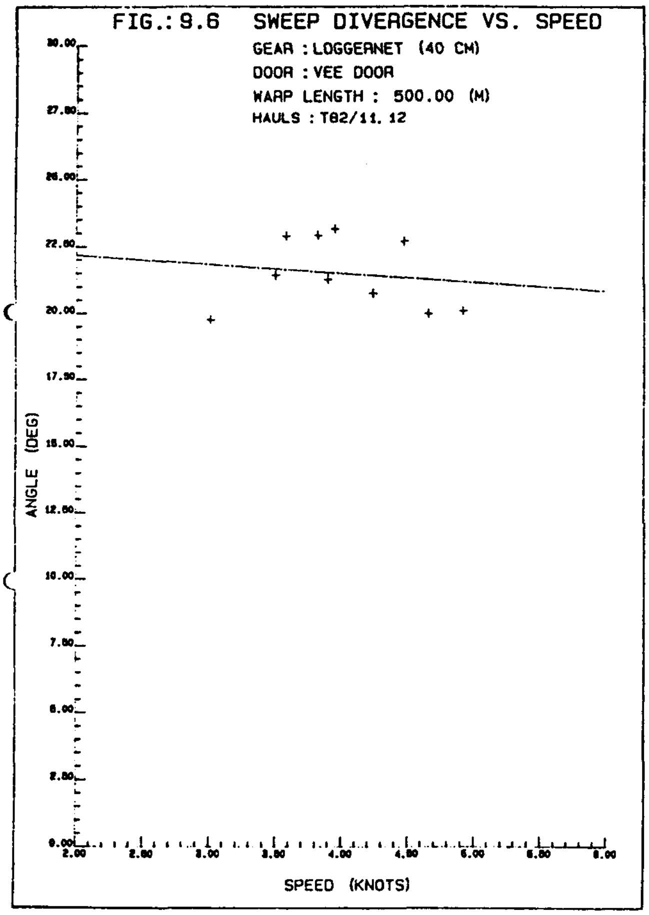


FIG.: 9.6 SWEEP DIVERGENCE VS. SPEED

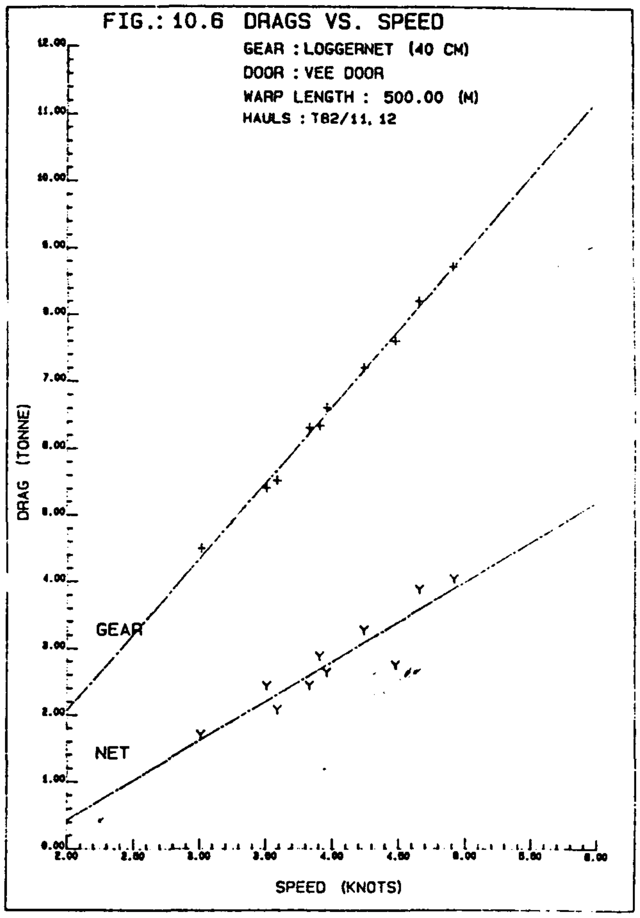


FIG.: 10.6 DRAGS VS. SPEED

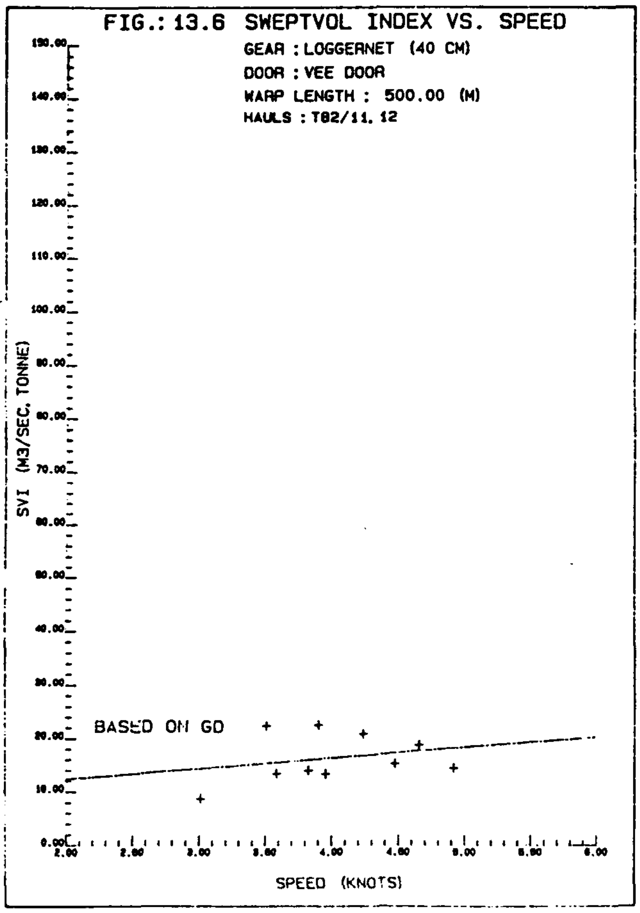


FIG.: 13.6 SWEPTVOL INDEX VS. SPEED

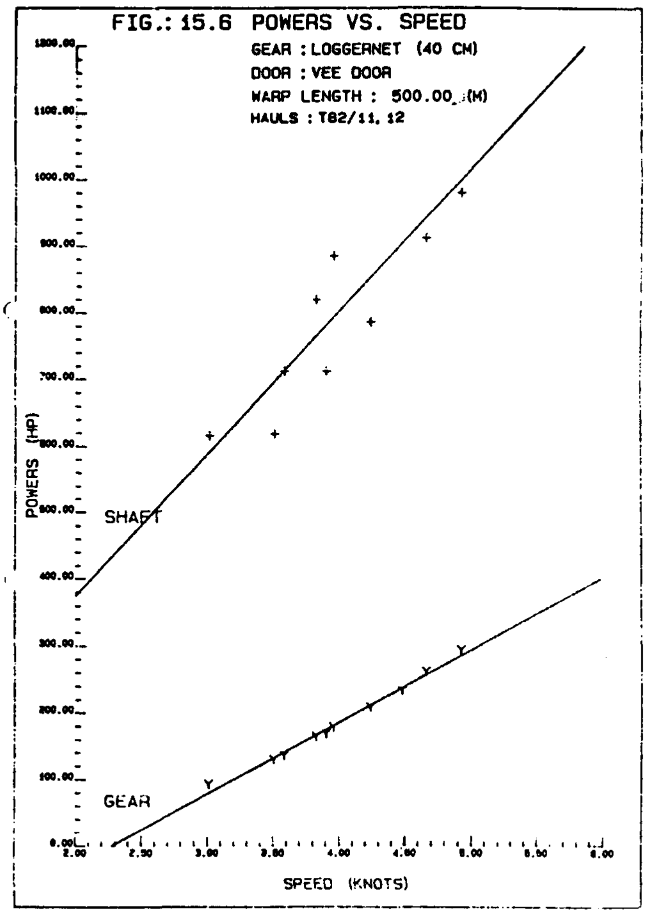


FIG.: 15.6 POWERS VS. SPEED

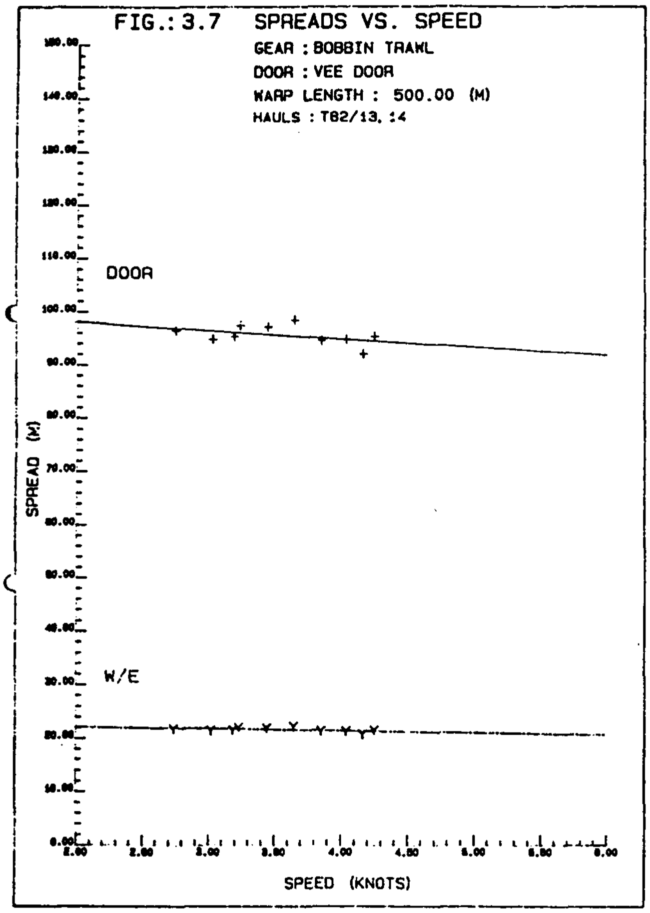


FIG.: 3.7 SPREADS VS. SPEED
GEAR : BOBBIN TRAWL
DOOR : VEE DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/13, 14
DOOR
W/E
SPREAD (M)
SPEED (KNOTS)

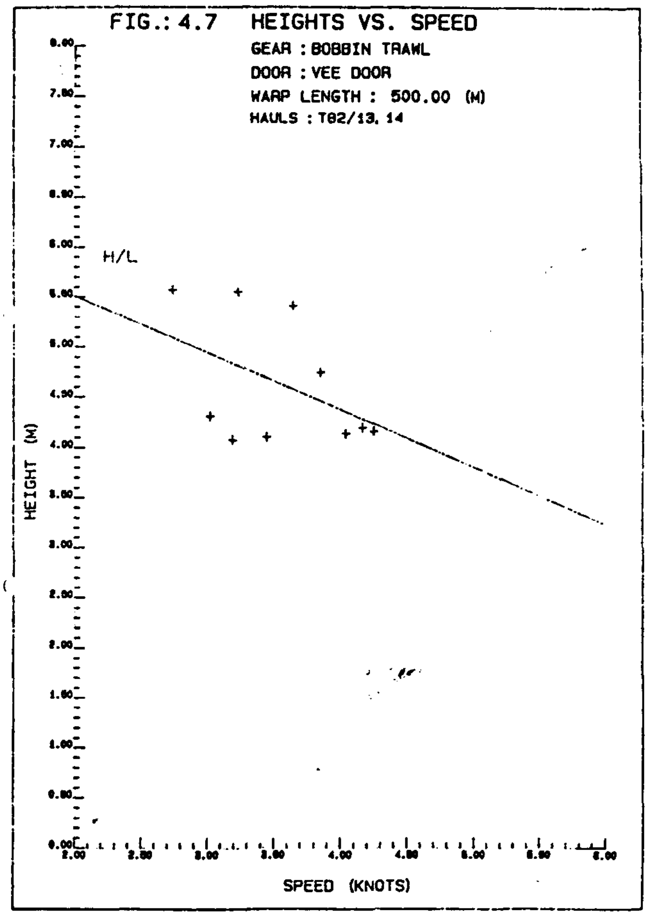


FIG.: 4.7 HEIGHTS VS. SPEED
GEAR : BOBBIN TRAWL
DOOR : VEE DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/13, 14
H/L
HEIGHT (M)
SPEED (KNOTS)

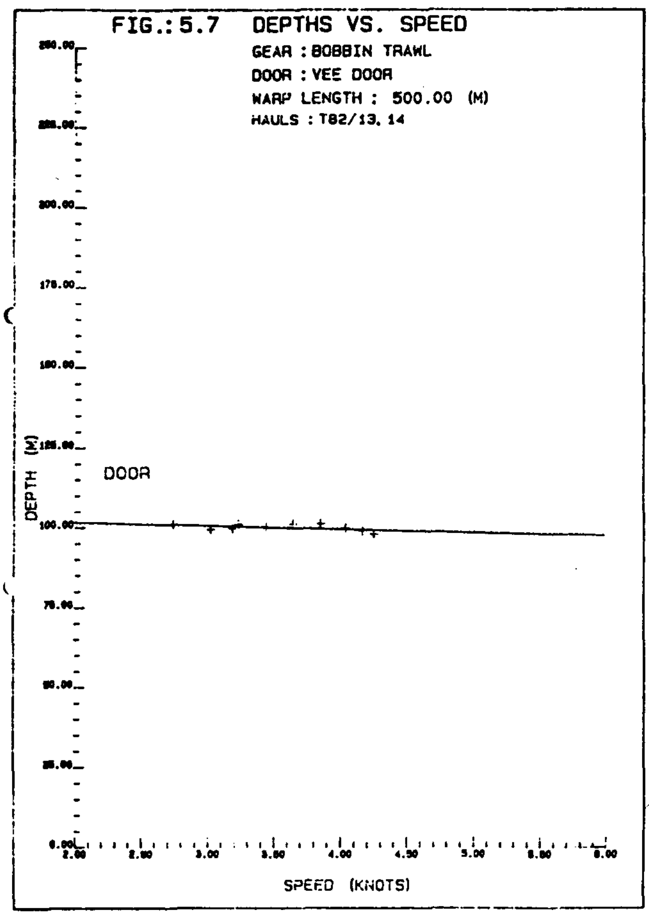


FIG.: 5.7 DEPTHS VS. SPEED
GEAR : BOBBIN TRAWL
DOOR : VEE DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/13, 14
DOOR
DEPTH (M)
SPEED (KNOTS)

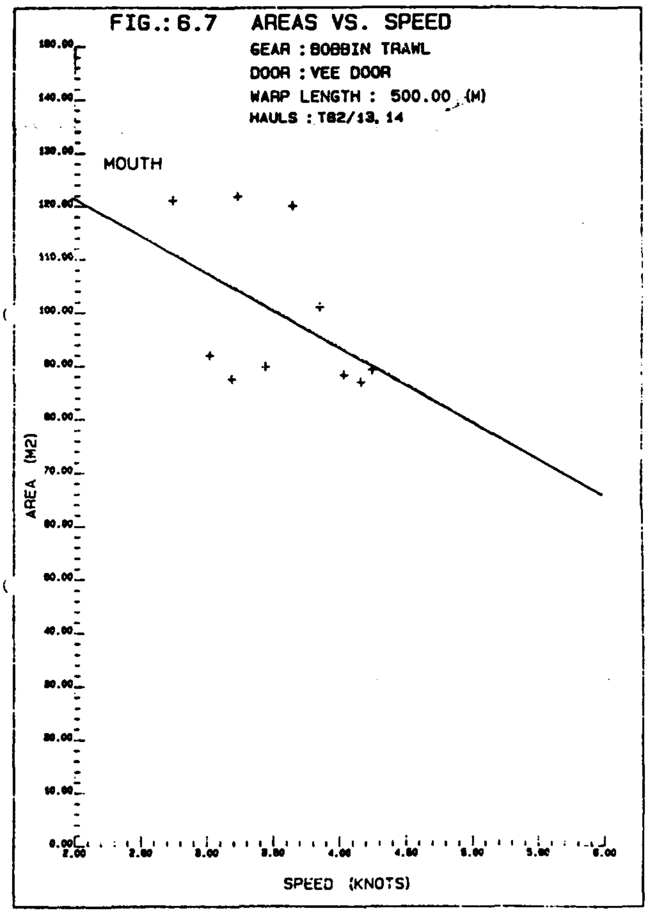


FIG.: 6.7 AREAS VS. SPEED
GEAR : BOBBIN TRAWL
DOOR : VEE DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/13, 14
MOUTH
AREA (M2)
SPEED (KNOTS)

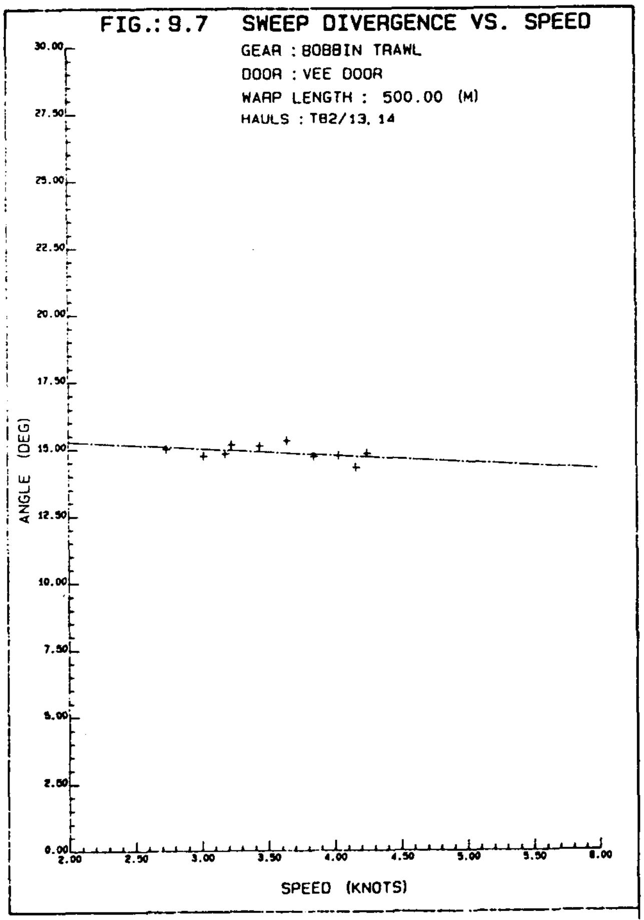


FIG.: 9.7 SWEEP DIVERGENCE VS. SPEED
GEAR : BOBBIN TRAWL
DOOR : VEE DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/13, 14
ANGLE (DEG)
SPEED (KNOTS)

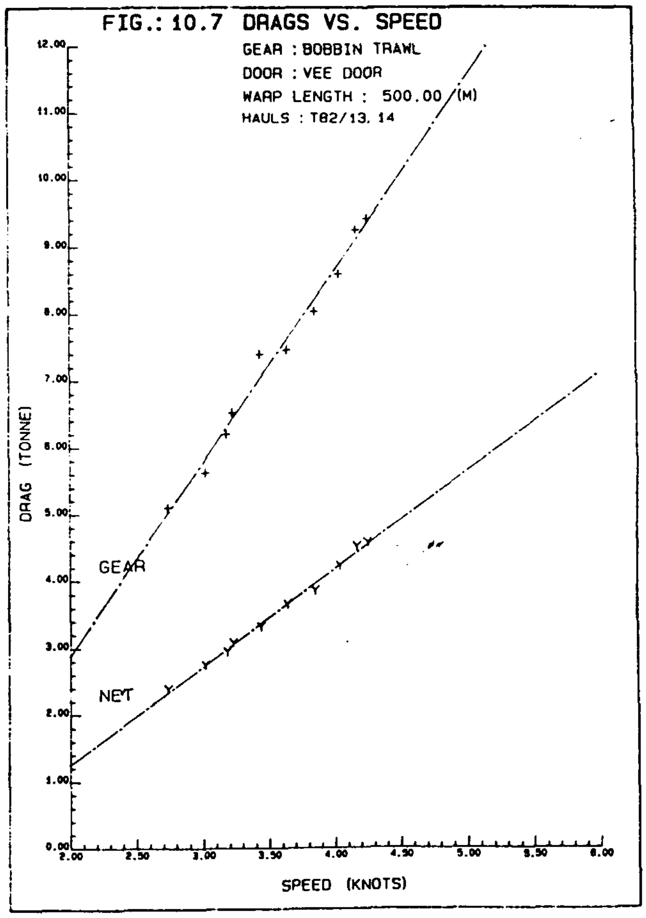


FIG.: 10.7 DRAGS VS. SPEED
GEAR : BOBBIN TRAWL
DOOR : VEE DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/13, 14
DRAG (TONNE)
GEAR
NET
SPEED (KNOTS)

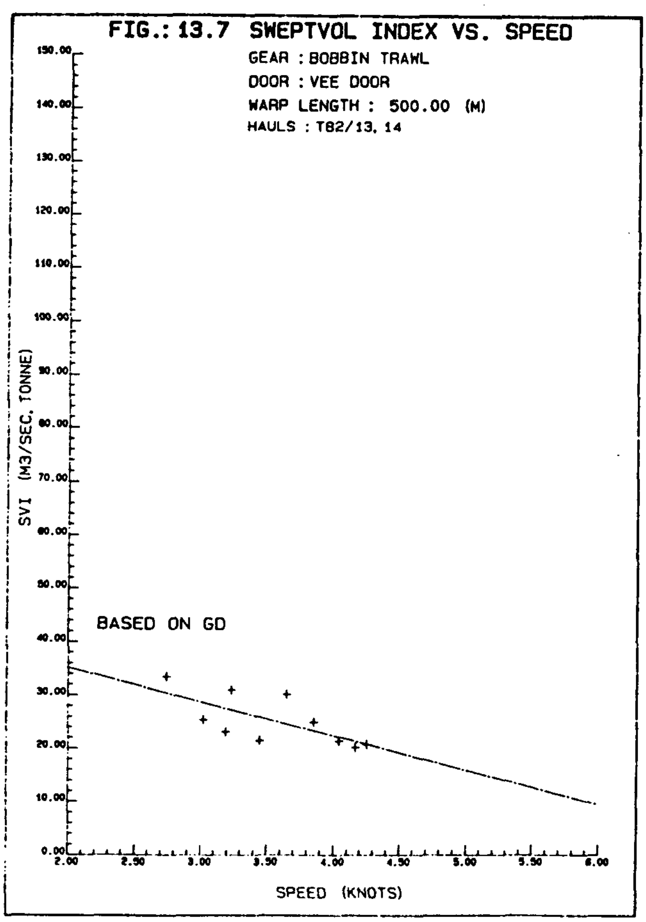


FIG.: 13.7 SWEPTVOL INDEX VS. SPEED
GEAR : BOBBIN TRAWL
DOOR : VEE DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/13, 14
SVI (M3/SEC, TONNE)
BASED ON GD
SPEED (KNOTS)

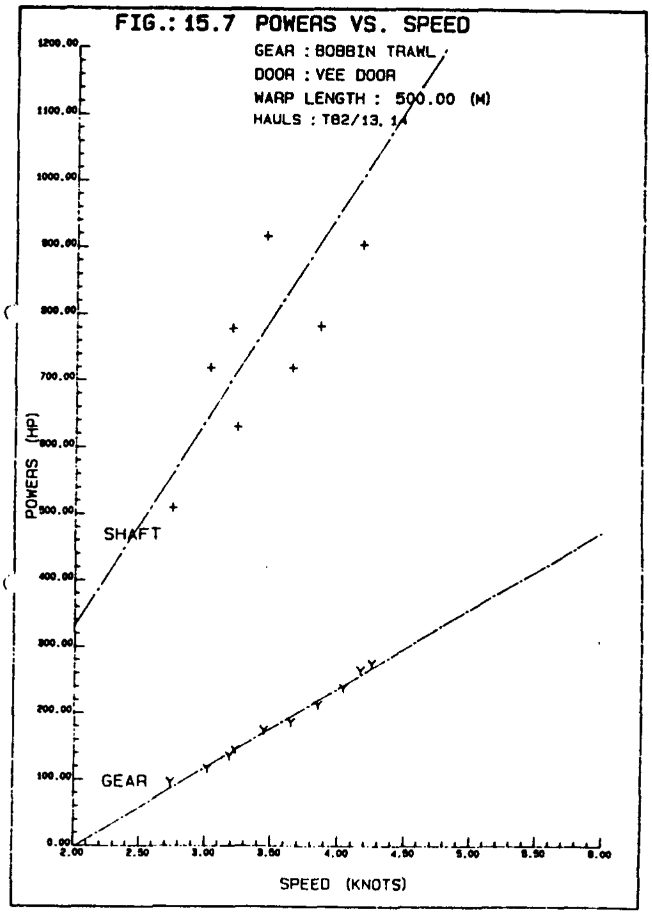


FIG.: 15.7 POWERS VS. SPEED
GEAR : BOBBIN TRAWL
DOOR : VEE DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/13, 14
POWERS (HP)
SHAFT
GEAR
SPEED (KNOTS)

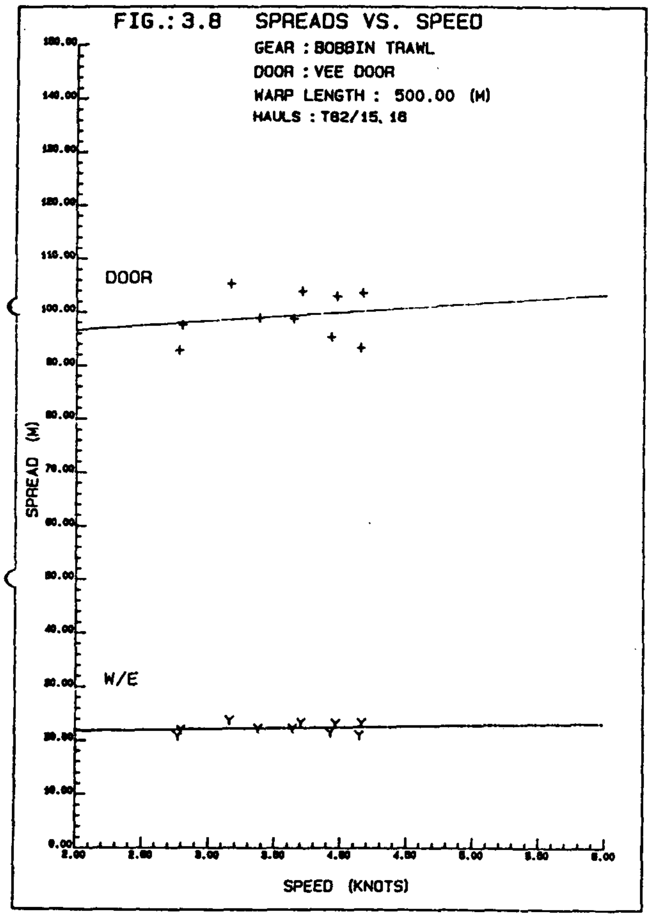


FIG.: 3.8 SPREADS VS. SPEED
GEAR : BOBBIN TRAWL
DOOR : VEE DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/15, 16
DOOR
W/E
SPREAD (M)
SPEED (KNOTS)

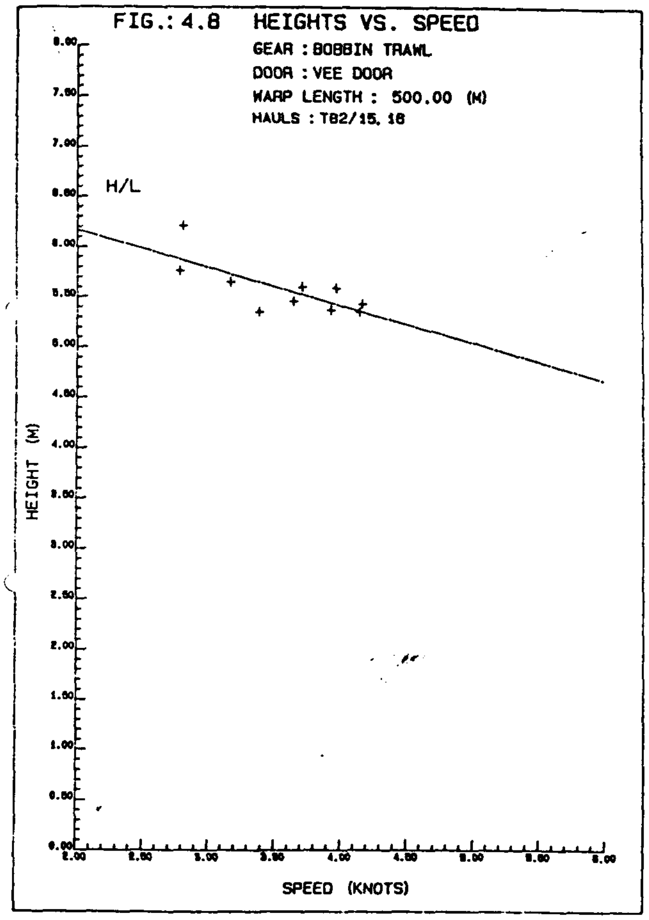


FIG.: 4.8 HEIGHTS VS. SPEED
GEAR : BOBBIN TRAWL
DOOR : VEE DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/15, 16
H/L
HEIGHT (M)
SPEED (KNOTS)

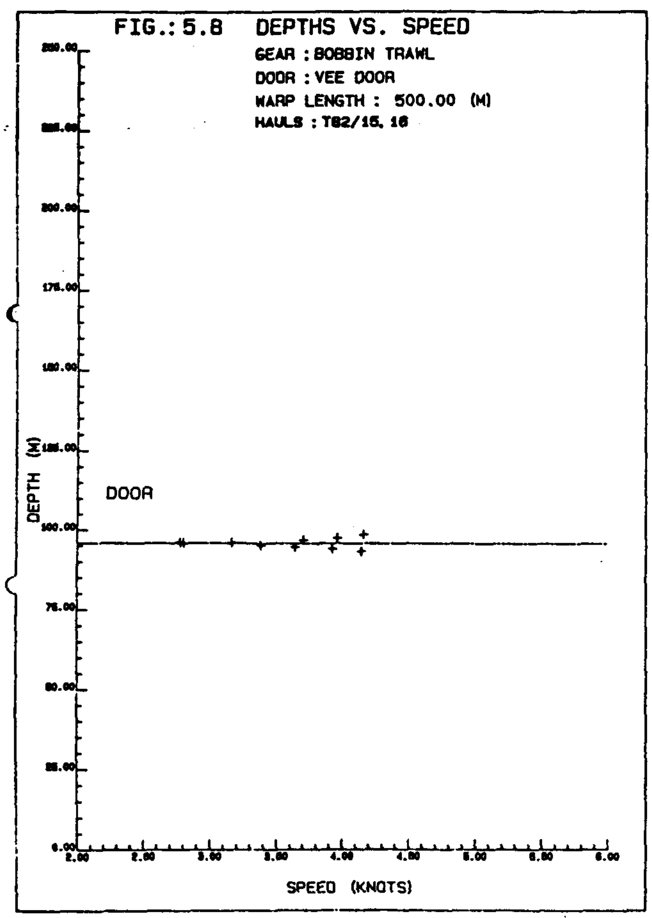


FIG.: 5.8 DEPTHS VS. SPEED
GEAR : BOBBIN TRAWL
DOOR : VEE DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/15, 16
DOOR
DEPTH (M)
SPEED (KNOTS)

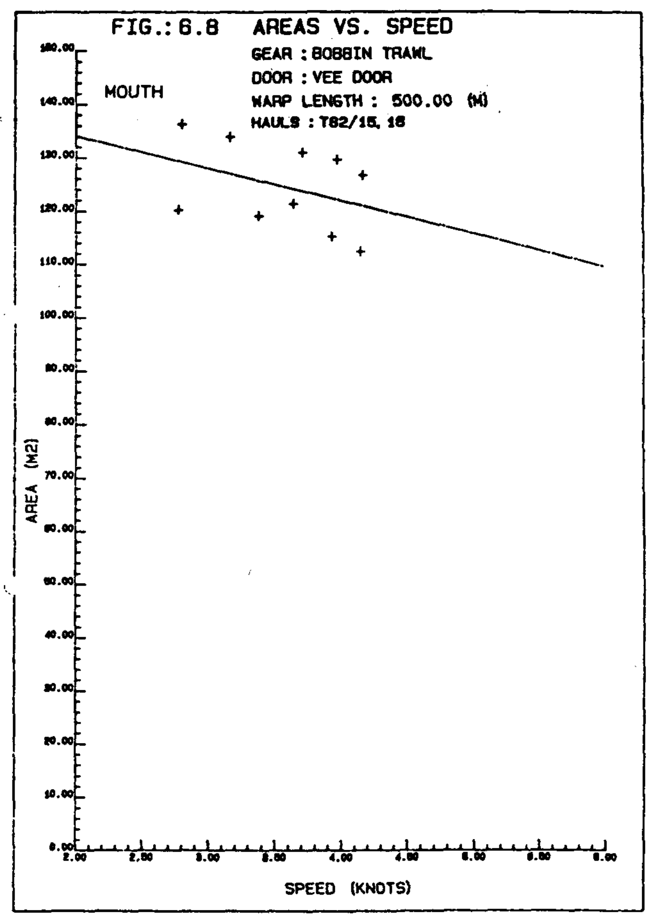


FIG.: 6.8 AREAS VS. SPEED
GEAR : BOBBIN TRAWL
DOOR : VEE DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/15, 16
MOUTH
AREA (M2)
SPEED (KNOTS)

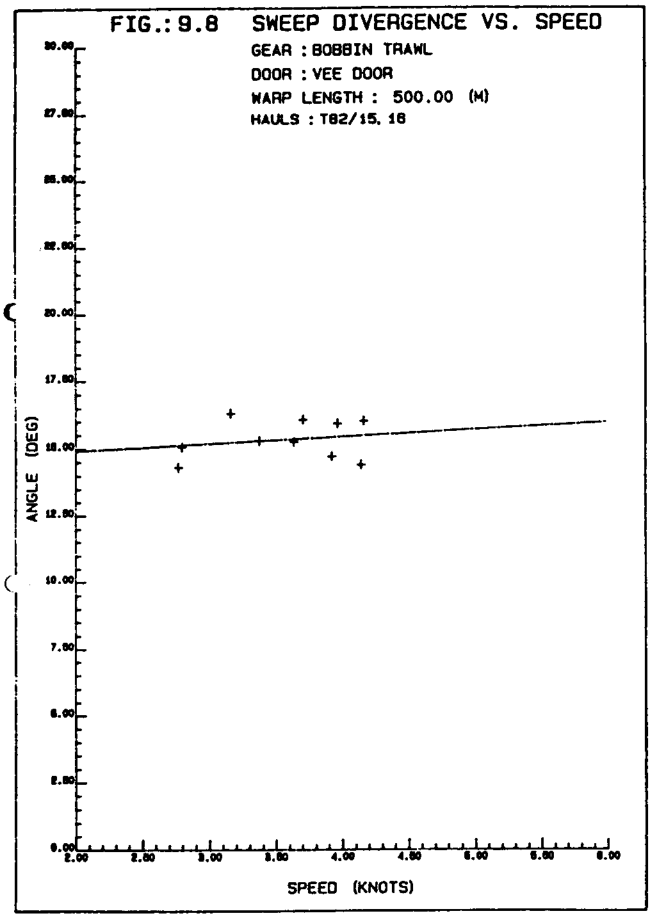


FIG.: 9.8 SWEEP DIVERGENCE VS. SPEED
GEAR : BOBBIN TRAWL
DOOR : VEE DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/15, 16
ANGLE (DEG)
SPEED (KNOTS)

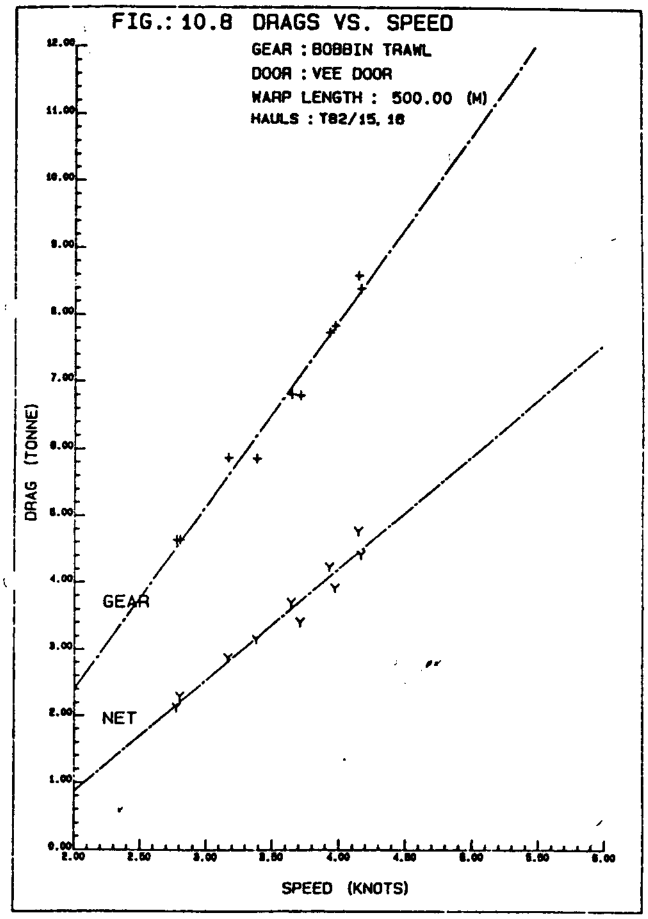


FIG.: 10.8 DRAGS VS. SPEED
GEAR : BOBBIN TRAWL
DOOR : VEE DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/15, 16
DRAG (TONNE)
GEAR
NET
SPEED (KNOTS)

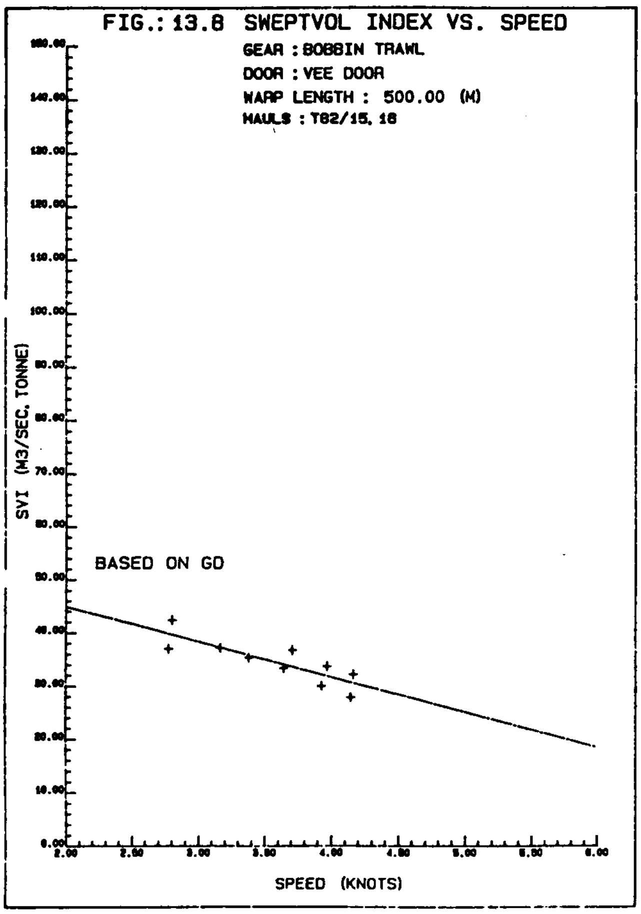


FIG.: 13.8 SWEPTVOL INDEX VS. SPEED
GEAR : BOBBIN TRAWL
DOOR : VEE DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/15, 16
SVI (M3/SEC, TONNE)
BASED ON GD
SPEED (KNOTS)

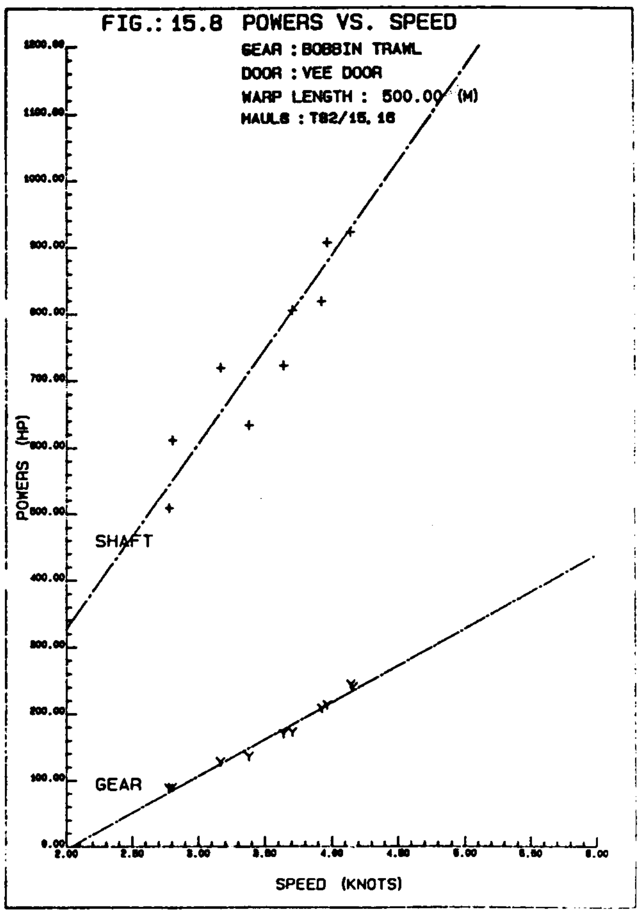


FIG.: 15.8 POWERS VS. SPEED
GEAR : BOBBIN TRAWL
DOOR : VEE DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/15, 16
POWERS (HP)
SHAFT
GEAR
SPEED (KNOTS)

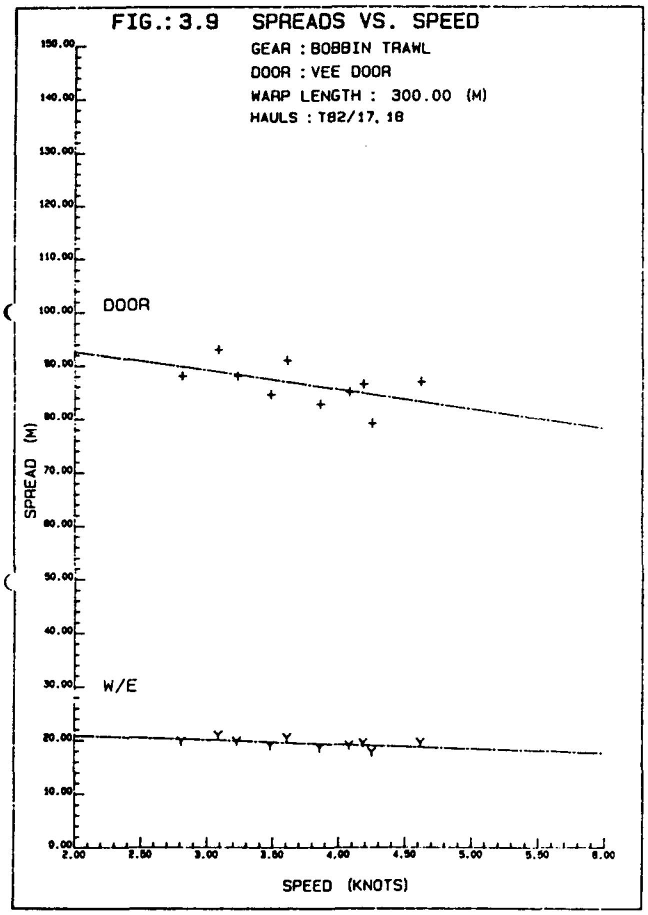


FIG.: 3.9 SPREADS VS. SPEED
GEAR : BOBBIN TRAWL
DOOR : VEE DOOR
WARP LENGTH : 300.00 (M)
HAULS : T82/17, 18
DOOR
W/E
SPREAD (M)
SPEED (KNOTS)

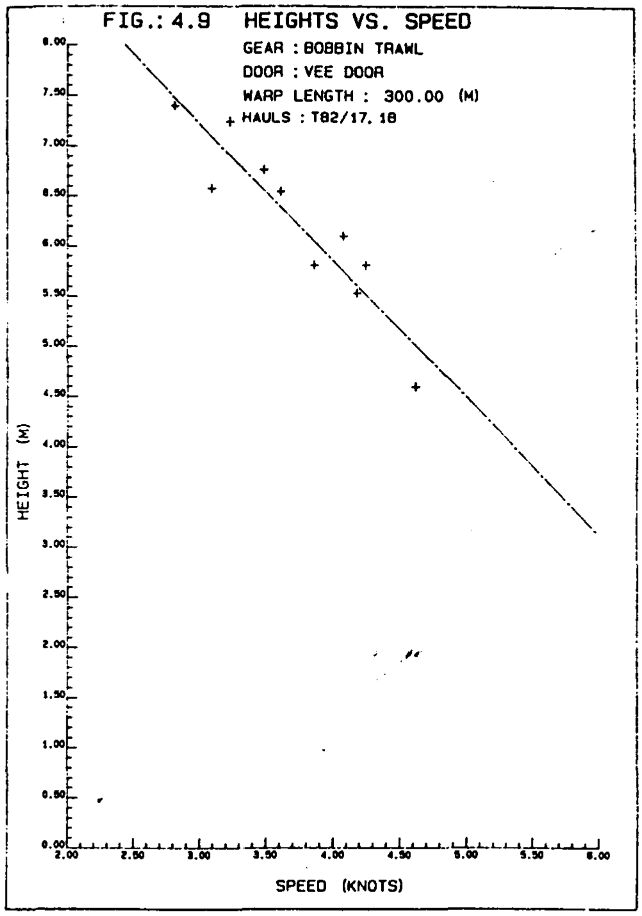


FIG.: 4.9 HEIGHTS VS. SPEED
GEAR : BOBBIN TRAWL
DOOR : VEE DOOR
WARP LENGTH : 300.00 (M)
HAULS : T82/17, 18
HEIGHT (M)
SPEED (KNOTS)

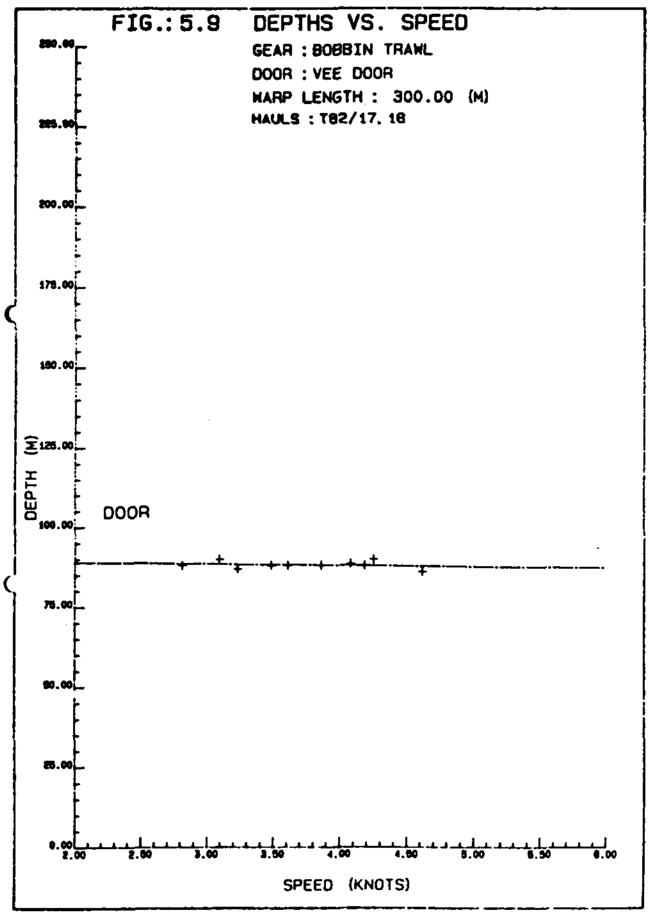


FIG.: 5.9 DEPTHS VS. SPEED
GEAR : BOBBIN TRAWL
DOOR : VEE DOOR
WARP LENGTH : 300.00 (M)
HAULS : T82/17, 18
DOOR
DEPTH (M)
SPEED (KNOTS)

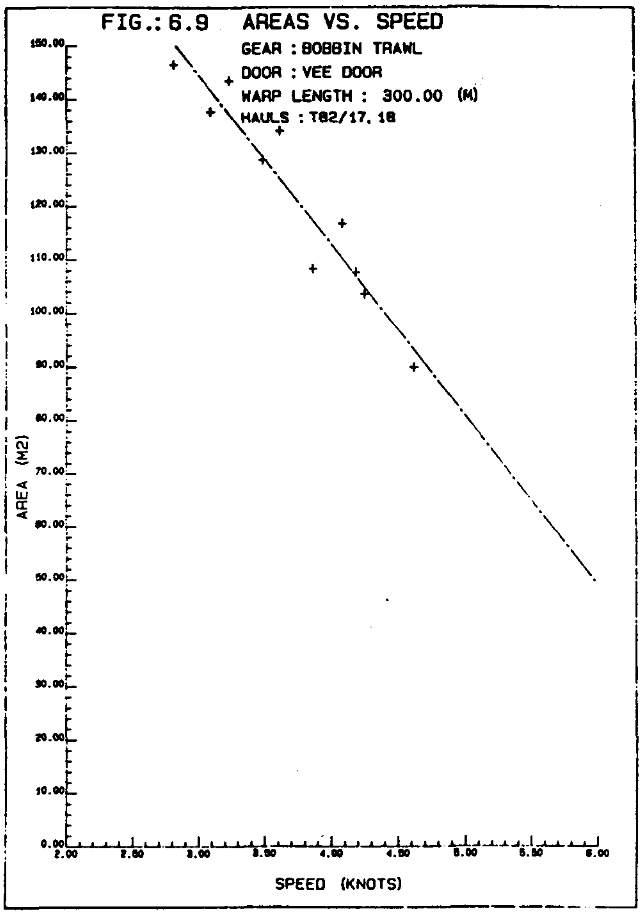


FIG.: 6.9 AREAS VS. SPEED
GEAR : BOBBIN TRAWL
DOOR : VEE DOOR
WARP LENGTH : 300.00 (M)
HAULS : T82/17, 18
AREA (M2)
SPEED (KNOTS)

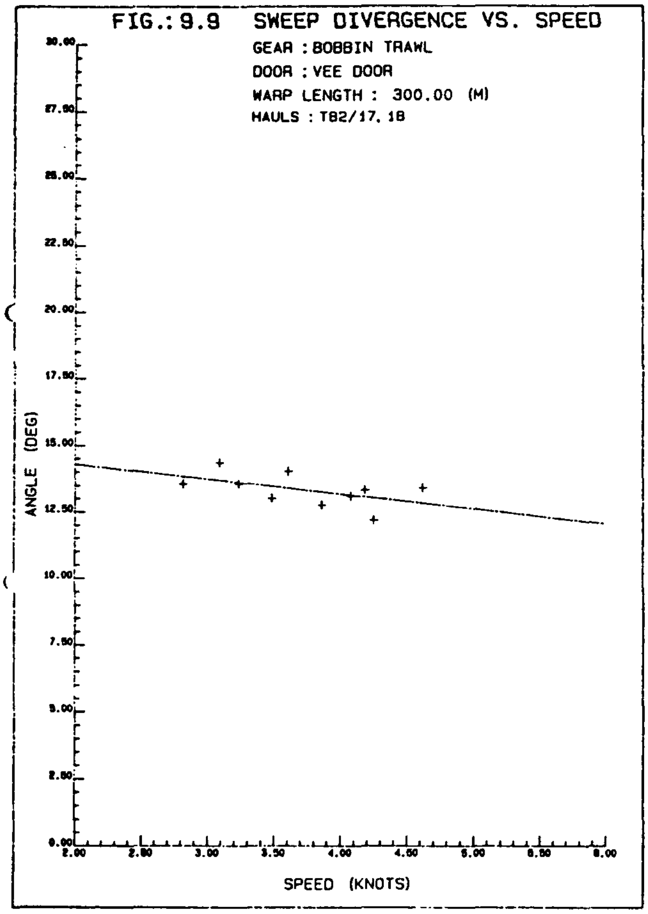


FIG.: 9.9 SWEEP DIVERGENCE VS. SPEED
GEAR : BOBBIN TRAWL
DOOR : VEE DOOR
WARP LENGTH : 300.00 (M)
HAULS : T82/17, 18
ANGLE (DEG)
SPEED (KNOTS)

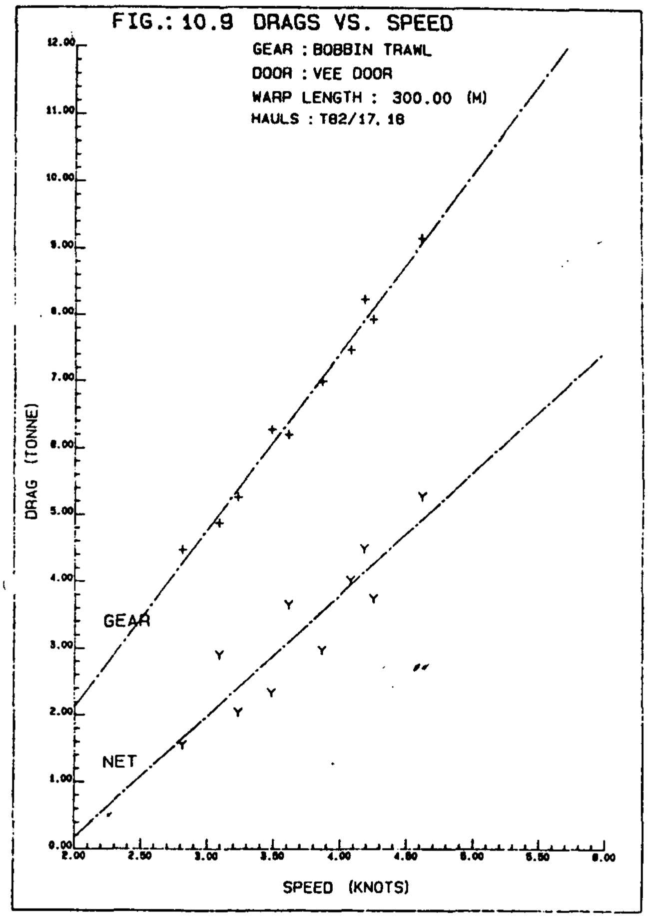


FIG.: 10.9 DRAGS VS. SPEED
GEAR : BOBBIN TRAWL
DOOR : VEE DOOR
WARP LENGTH : 300.00 (M)
HAULS : T82/17, 18
DRAG (TONNE)
GEAR
NET
SPEED (KNOTS)

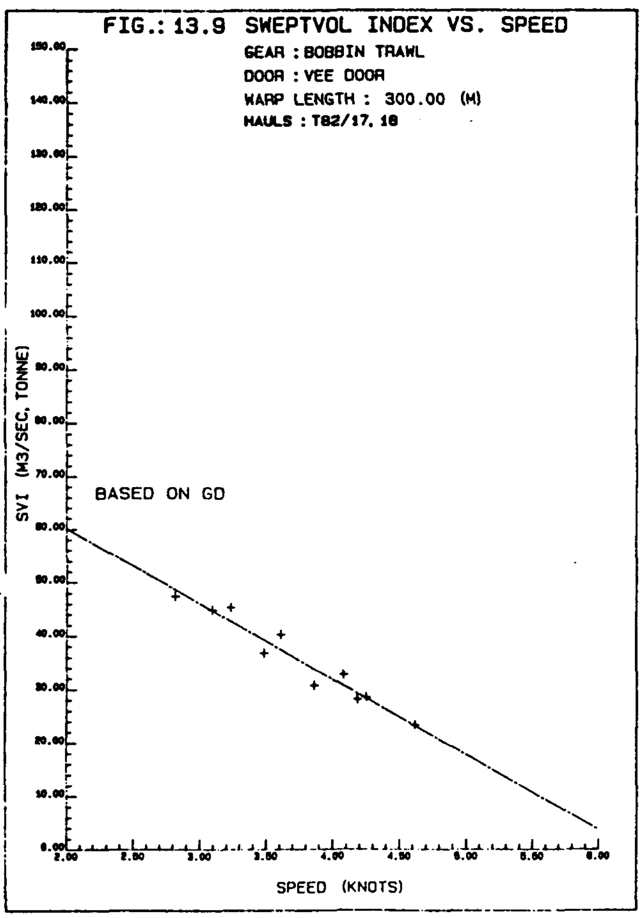


FIG.: 13.9 SWEPTVOL INDEX VS. SPEED
GEAR : BOBBIN TRAWL
DOOR : VEE DOOR
WARP LENGTH : 300.00 (M)
HAULS : T82/17, 18
SVI (M3/SEC, TONNE)
BASED ON GD
SPEED (KNOTS)

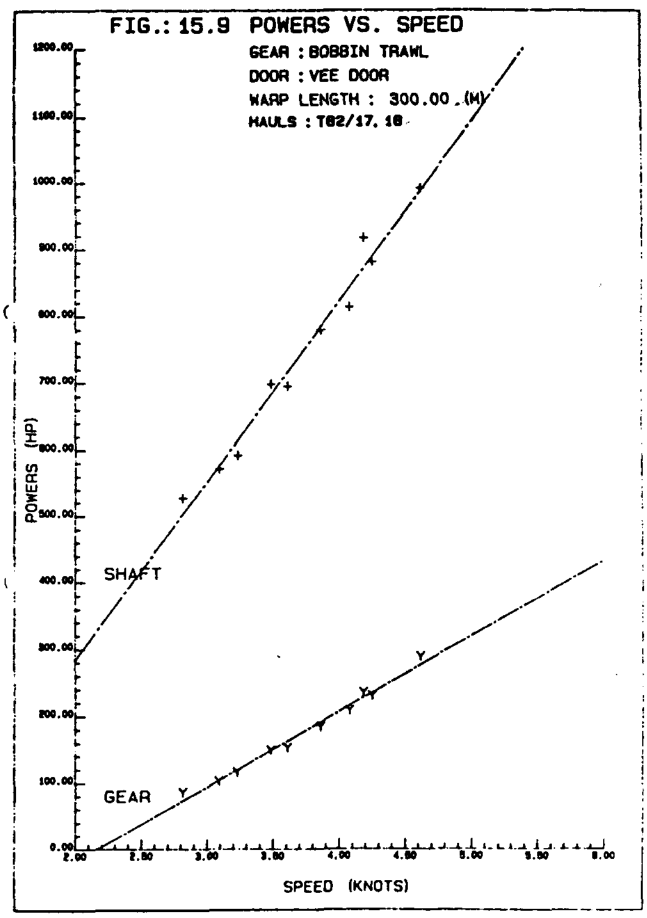


FIG.: 15.9 POWERS VS. SPEED
GEAR : BOBBIN TRAWL
DOOR : VEE DOOR
WARP LENGTH : 300.00 (M)
HAULS : T82/17, 18
POWERS (HP)
SHAFT
GEAR
SPEED (KNOTS)

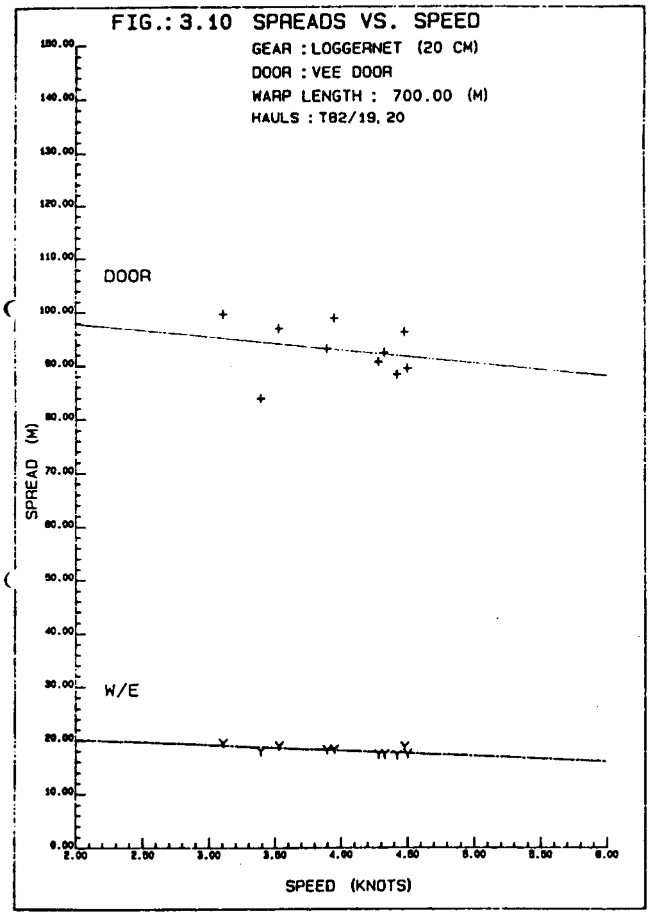


FIG.: 3.10 SPREADS VS. SPEED
GEAR : LOGGERNET (20 CM)
DOOR : VEE DOOR
WARP LENGTH : 700.00 (M)
HAULS : T82/19, 20
DOOR
W/E
SPREAD (M)
SPEED (KNOTS)

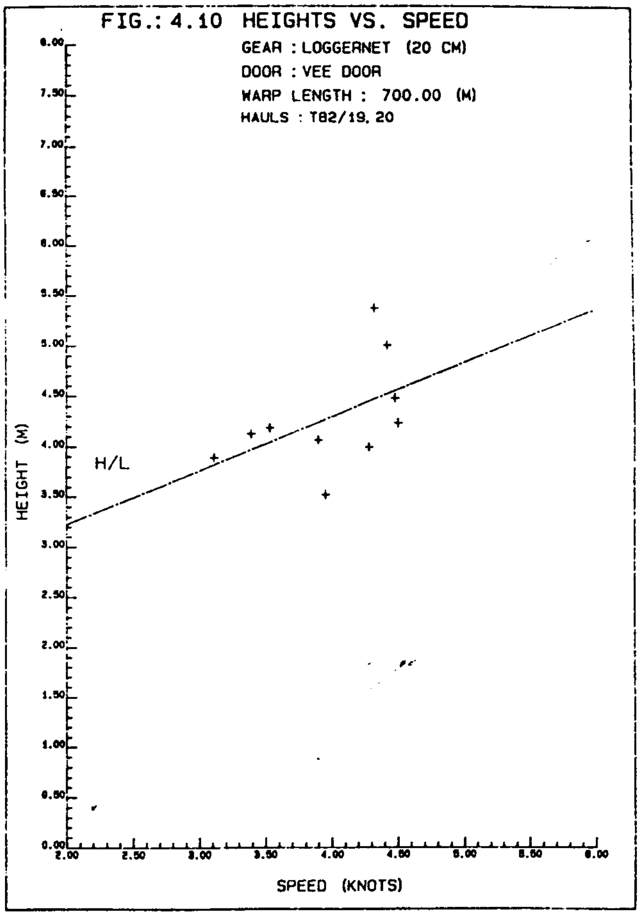


FIG.: 4.10 HEIGHTS VS. SPEED
GEAR : LOGGERNET (20 CM)
DOOR : VEE DOOR
WARP LENGTH : 700.00 (M)
HAULS : T82/19, 20
H/L
HEIGHT (M)
SPEED (KNOTS)

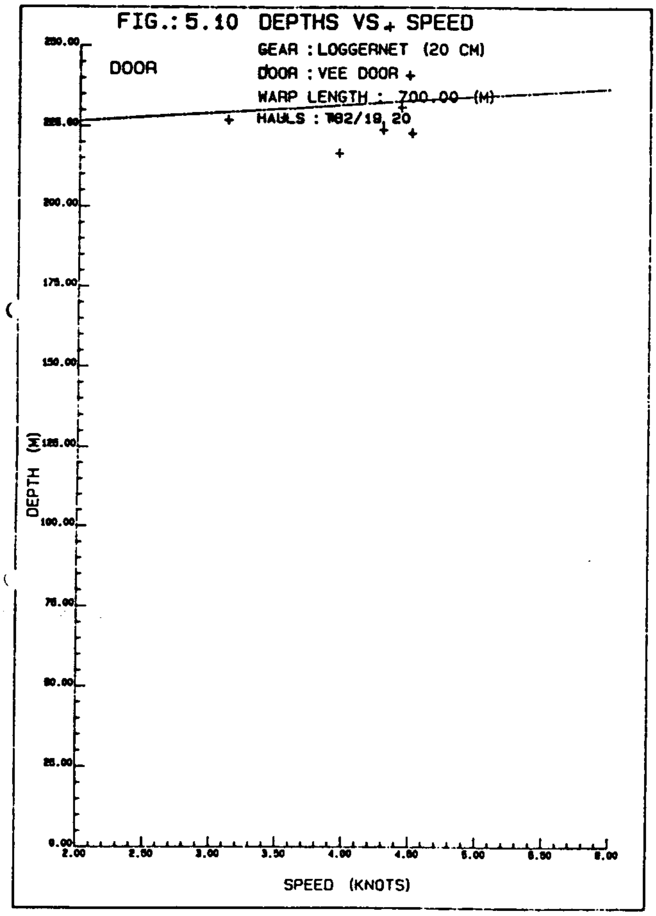


FIG.: 5.10 DEPTHS VS. SPEED
GEAR : LOGGERNET (20 CM)
DOOR : VEE DOOR
WARP LENGTH : 700.00 (M)
HAULS : T82/19, 20
DOOR
DEPTH (M)
SPEED (KNOTS)

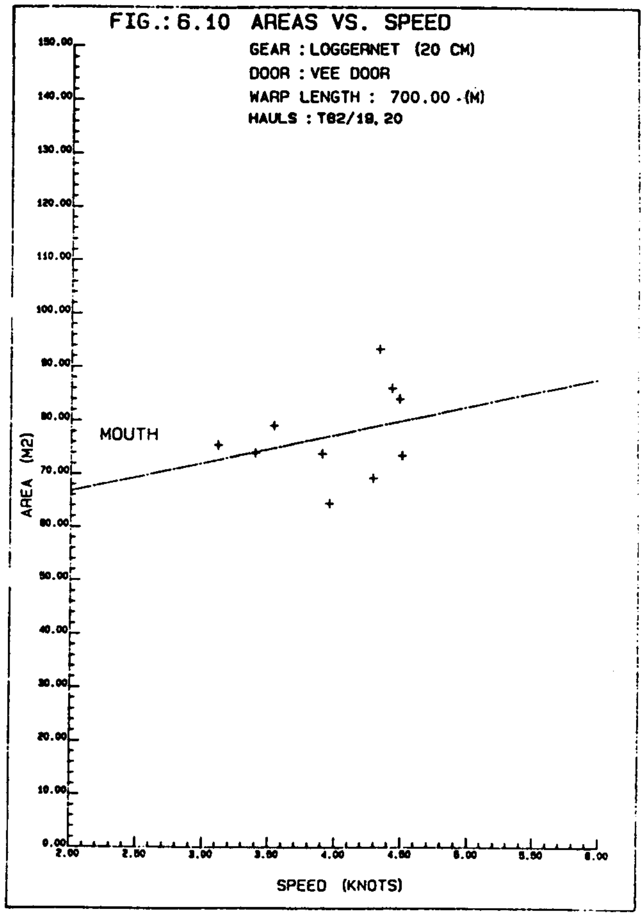


FIG.: 6.10 AREAS VS. SPEED
GEAR : LOGGERNET (20 CM)
DOOR : VEE DOOR
WARP LENGTH : 700.00 (M)
HAULS : T82/19, 20
MOUTH
AREA (M2)
SPEED (KNOTS)

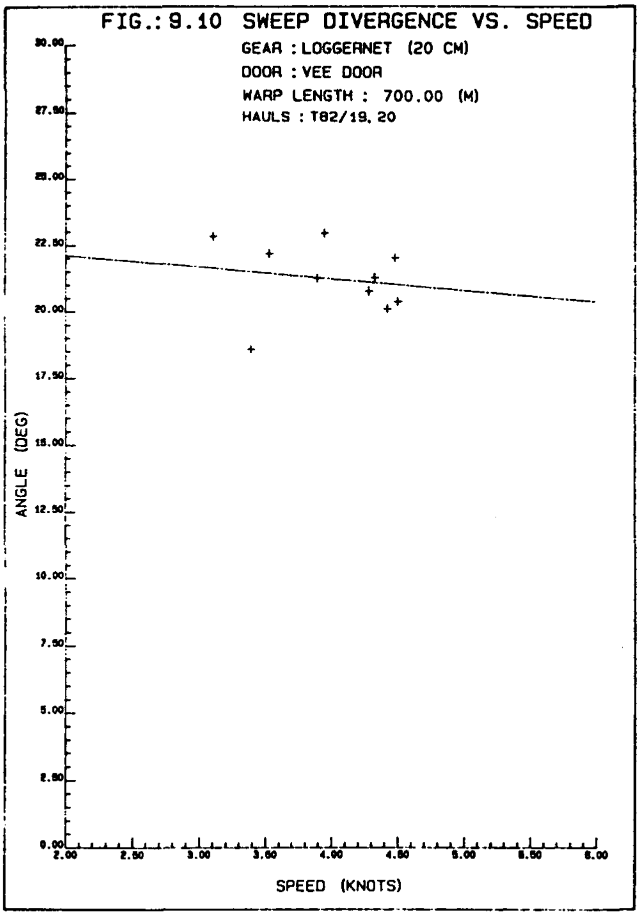


FIG.: 9.10 SWEEP DIVERGENCE VS. SPEED
GEAR : LOGGERNET (20 CM)
DOOR : VEE DOOR
WARP LENGTH : 700.00 (M)
HAULS : T82/19, 20
ANGLE (DEG)
SPEED (KNOTS)

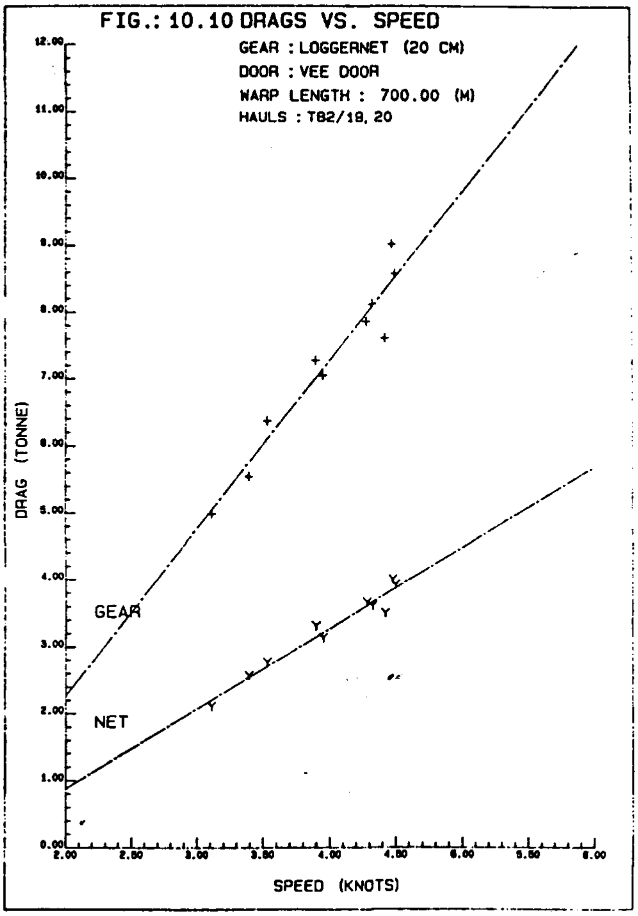


FIG.: 10.10 DRAGS VS. SPEED
GEAR : LOGGERNET (20 CM)
DOOR : VEE DOOR
WARP LENGTH : 700.00 (M)
HAULS : T82/19, 20
DRAG (TONNE)
GEAR
NET
SPEED (KNOTS)

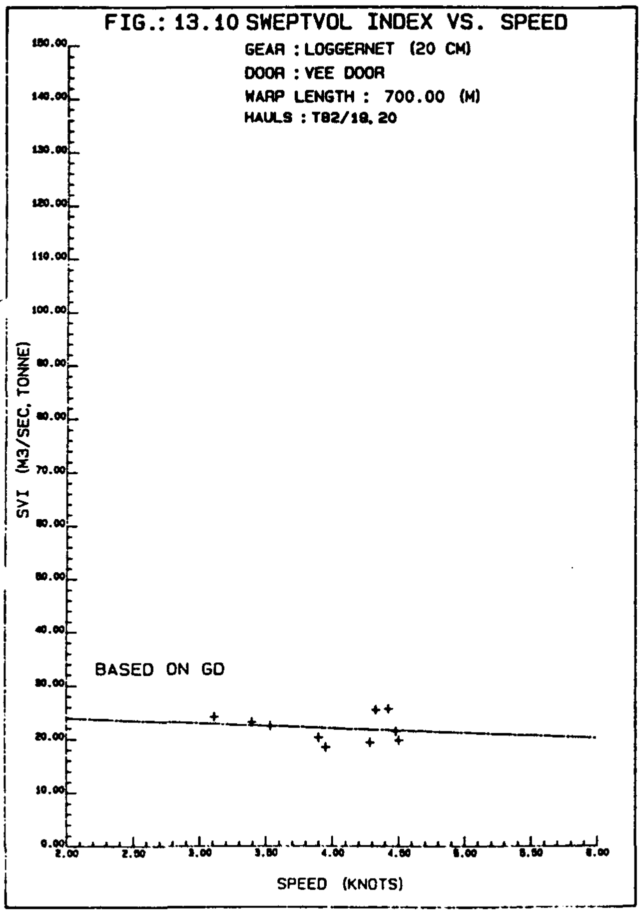


FIG.: 13.10 SWEPTVOL INDEX VS. SPEED
GEAR : LOGGERNET (20 CM)
DOOR : VEE DOOR
WARP LENGTH : 700.00 (M)
HAULS : T82/19, 20
SVI (M3/SEC, TONNE)
BASED ON GD
SPEED (KNOTS)

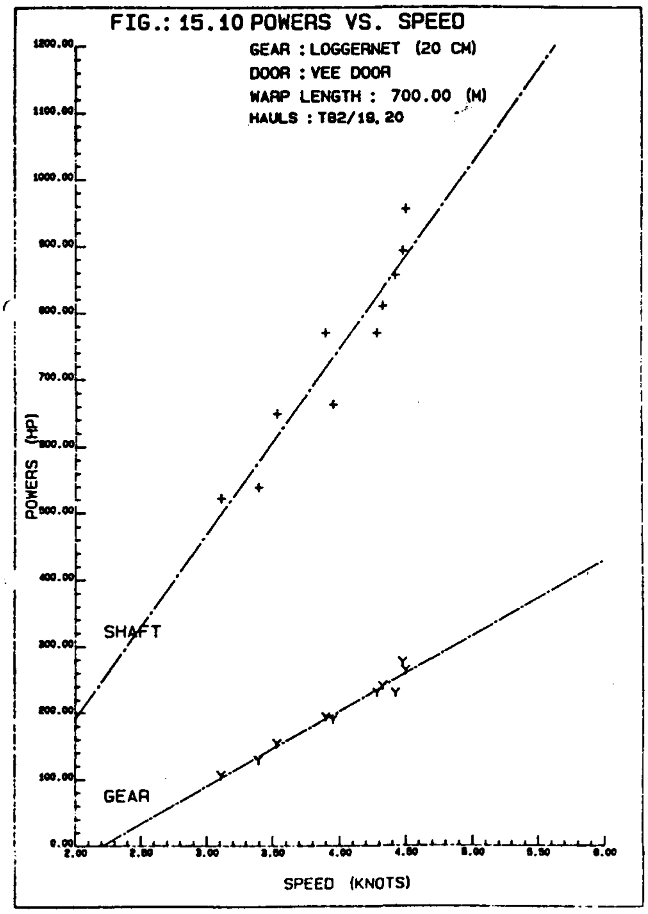


FIG.: 15.10 POWERS VS. SPEED
GEAR : LOGGERNET (20 CM)
DOOR : VEE DOOR
WARP LENGTH : 700.00 (M)
HAULS : T82/19, 20
POWERS (HP)
SHAFT
GEAR
SPEED (KNOTS)

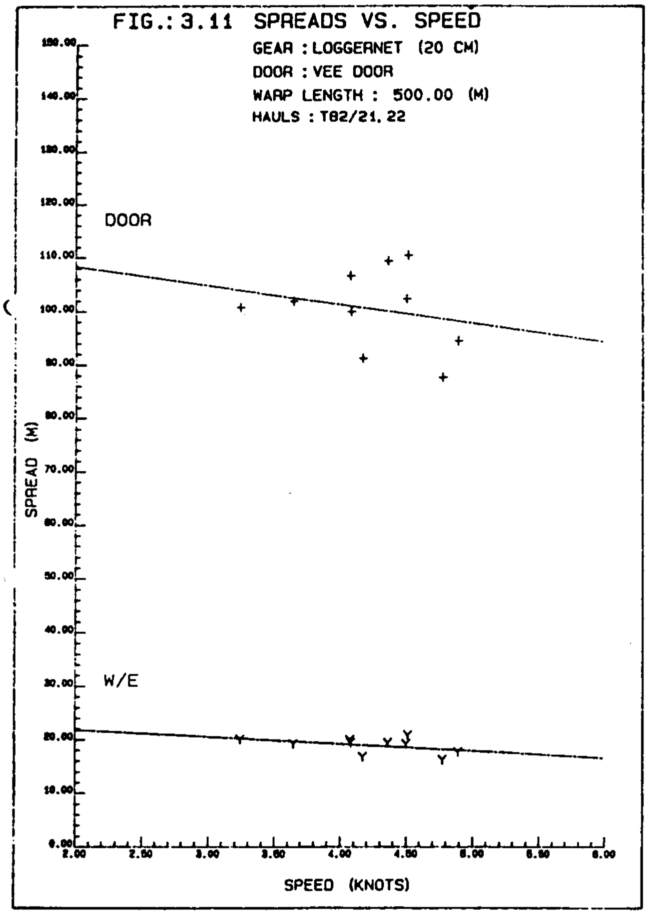


FIG.: 3.11 SPREADS VS. SPEED

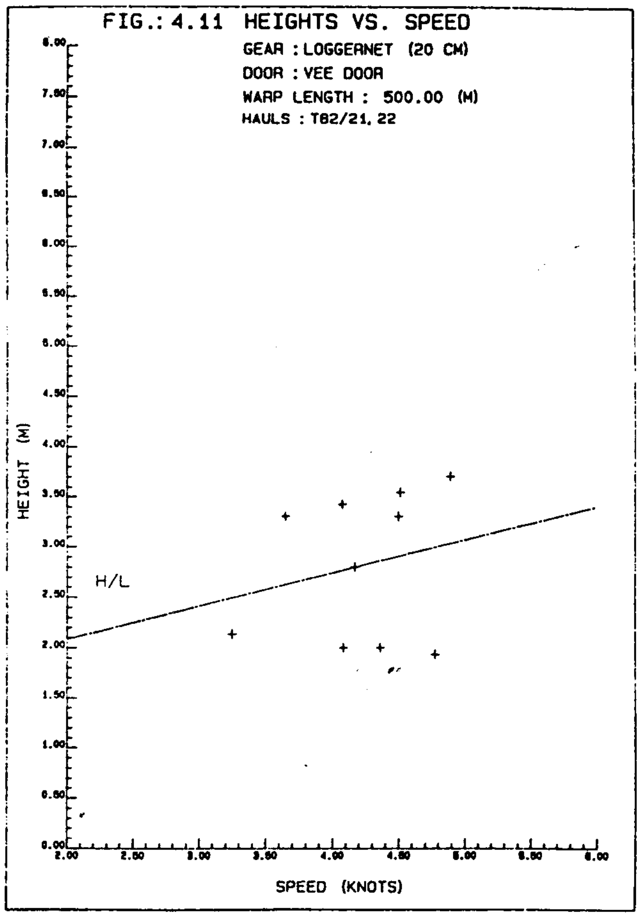


FIG.: 4.11 HEIGHTS VS. SPEED

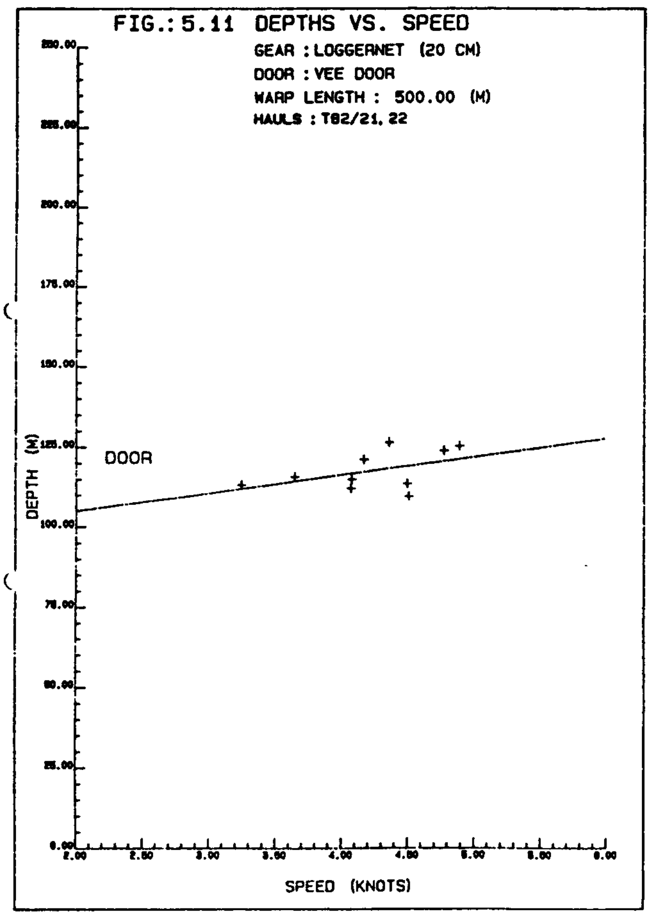


FIG.: 5.11 DEPTHS VS. SPEED

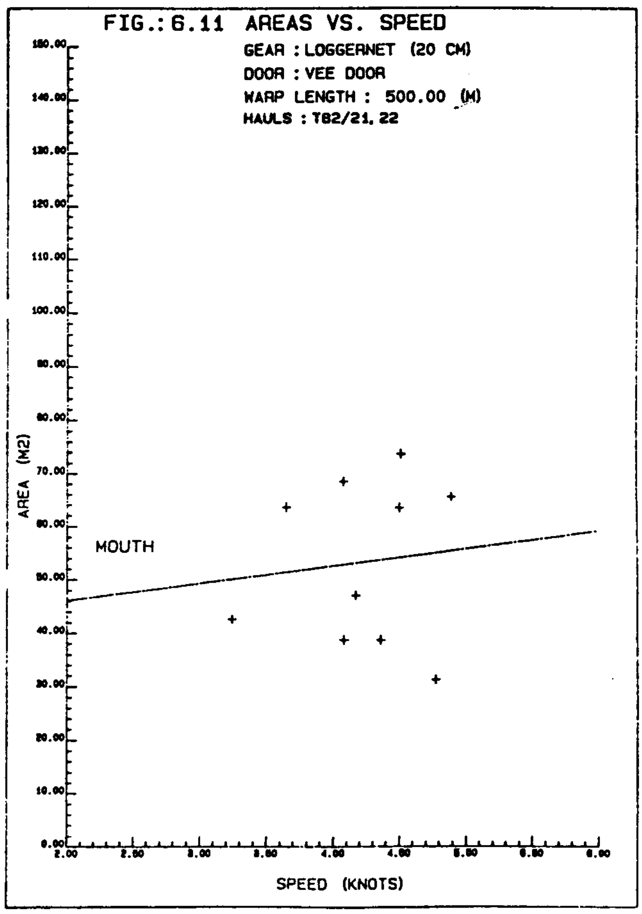


FIG.: 6.11 AREAS VS. SPEED

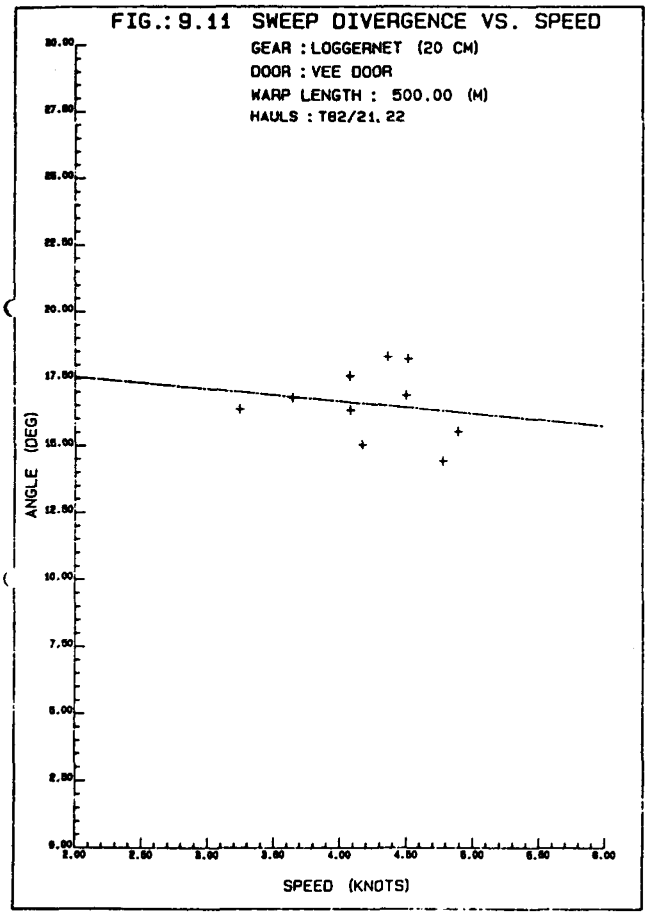


FIG.: 9.11 SWEEP DIVERGENCE VS. SPEED
GEAR : LOGGERNET (20 CM)
DOOR : VEE DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/21, 22
ANGLE (DEG)
SPEED (KNOTS)

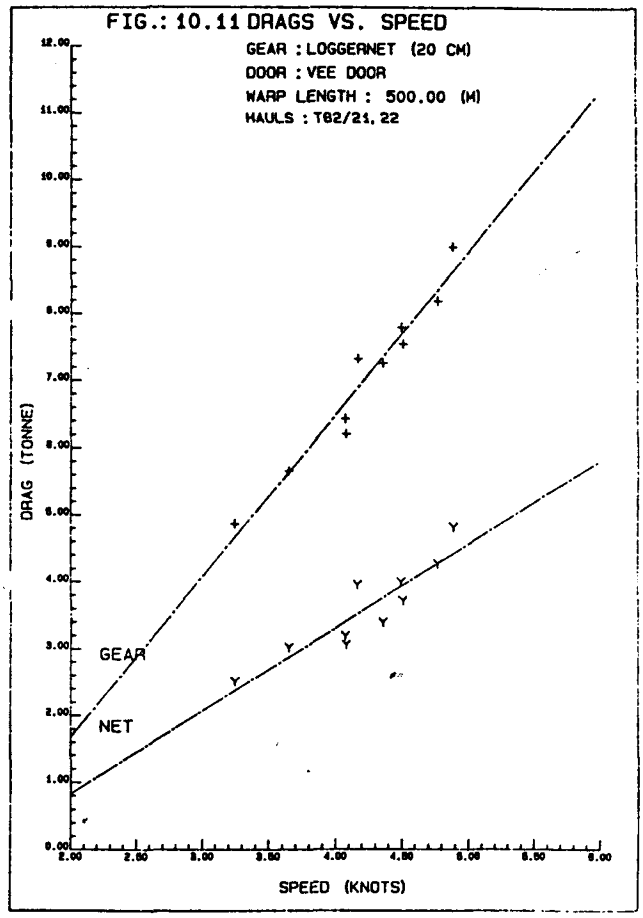


FIG.: 10.11 DRAGS VS. SPEED
GEAR : LOGGERNET (20 CM)
DOOR : VEE DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/21, 22
DRAG (TONNE)
GEAR
NET
SPEED (KNOTS)

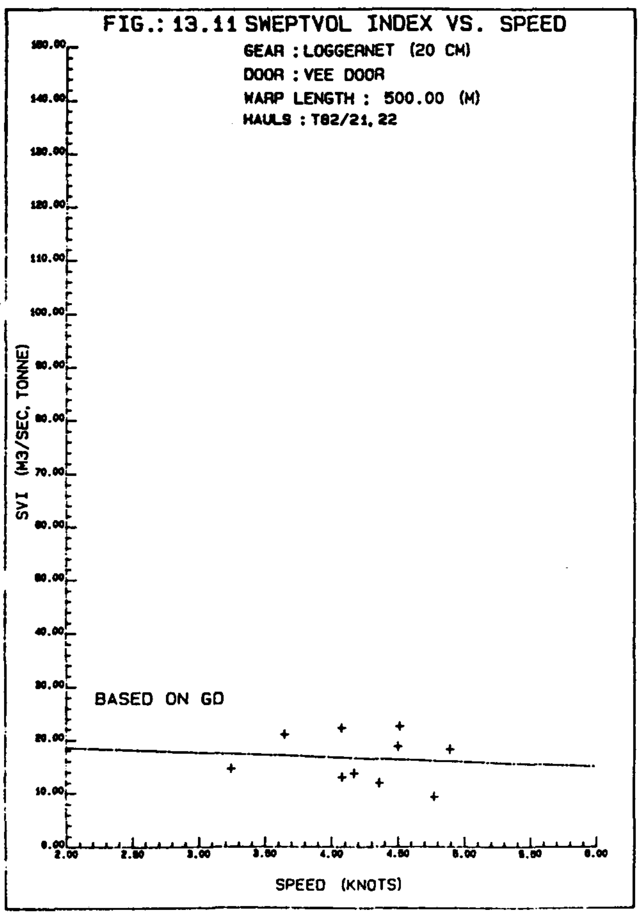


FIG.: 13.11 SWEPTVOL INDEX VS. SPEED
GEAR : LOGGERNET (20 CM)
DOOR : VEE DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/21, 22
SVI (M3/SEC, TONNE)
BASED ON GD
SPEED (KNOTS)

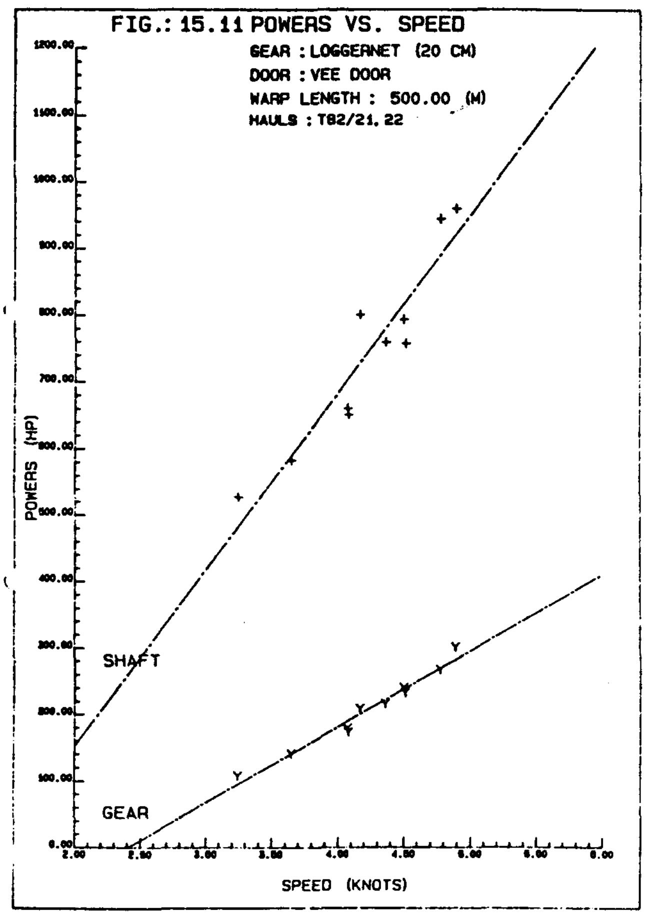


FIG.: 15.11 POWERS VS. SPEED
GEAR : LOGGERNET (20 CM)
DOOR : VEE DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/21, 22
POWERS (HP)
SHAFT
GEAR
SPEED (KNOTS)

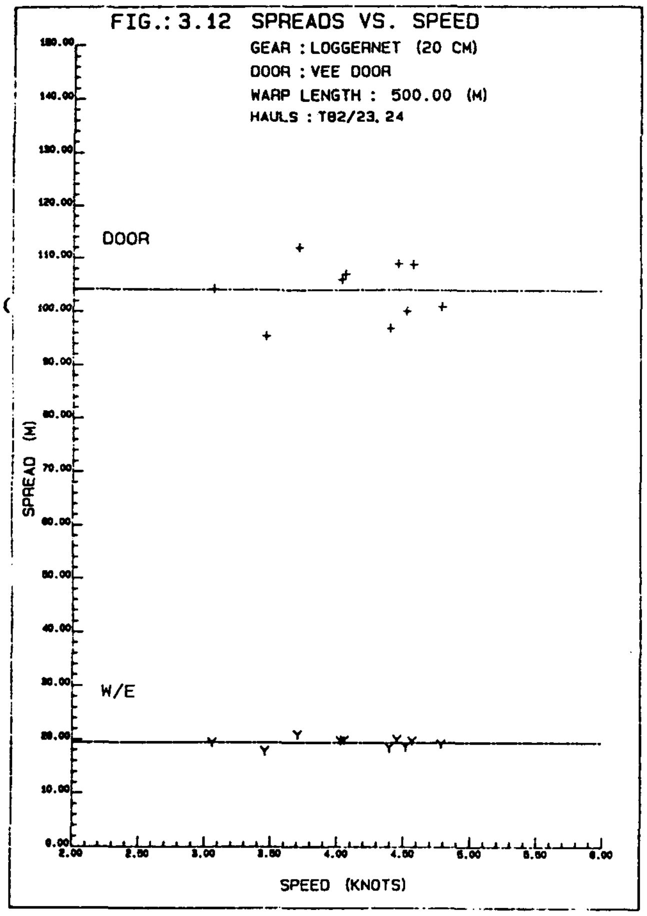


FIG.: 3.12 SPREADS VS. SPEED

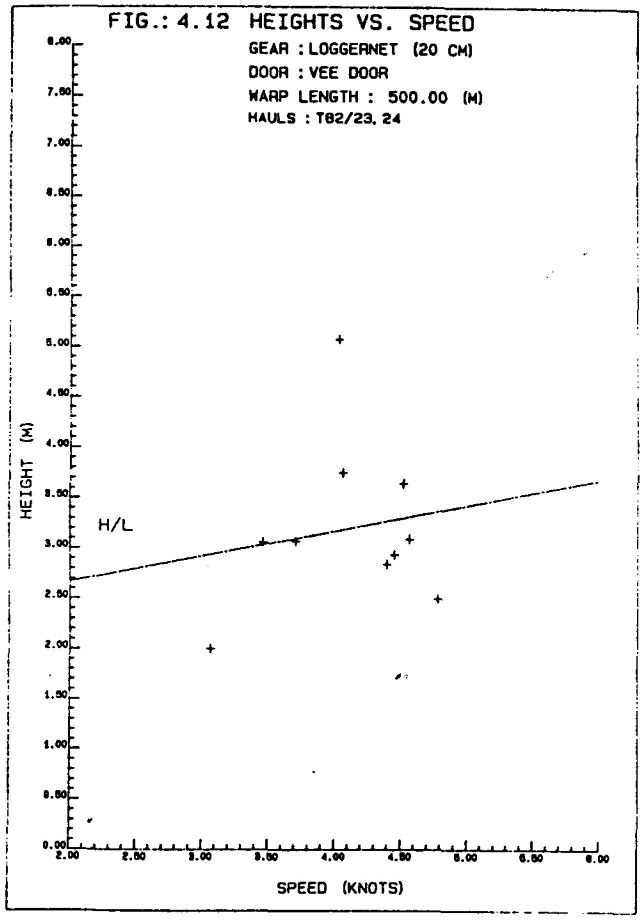


FIG.: 4.12 HEIGHTS VS. SPEED

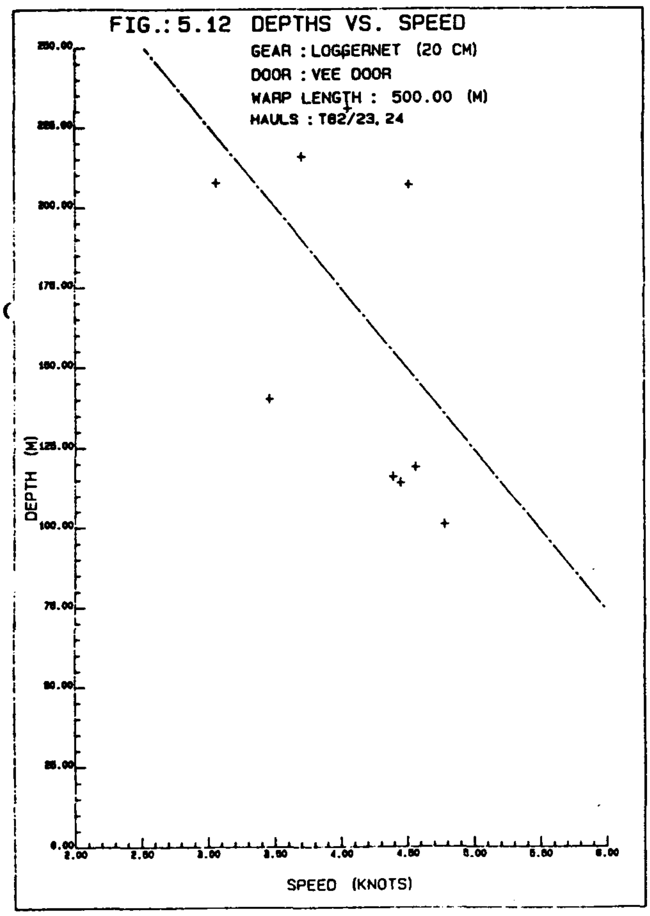


FIG.: 5.12 DEPTHS VS. SPEED

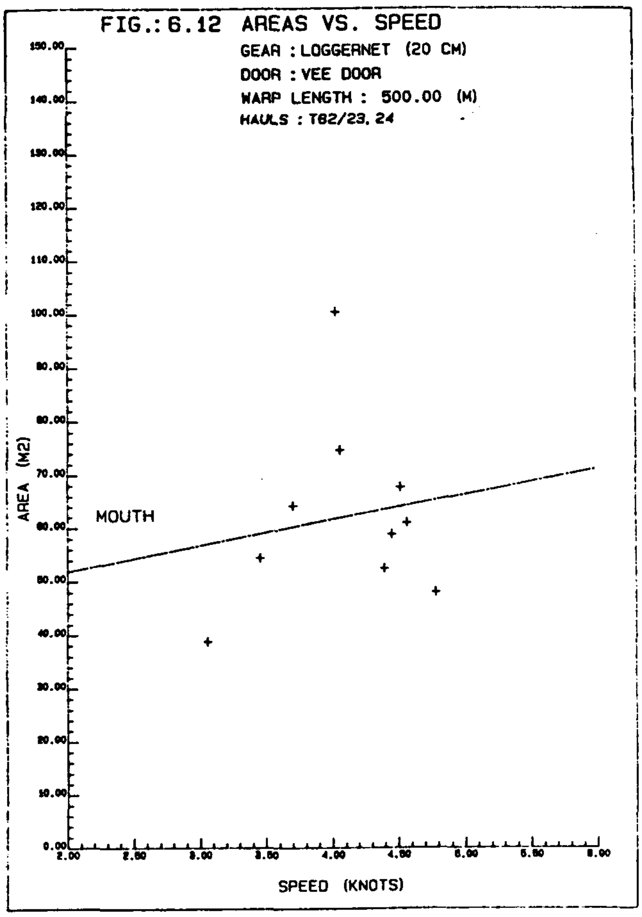


FIG.: 6.12 AREAS VS. SPEED

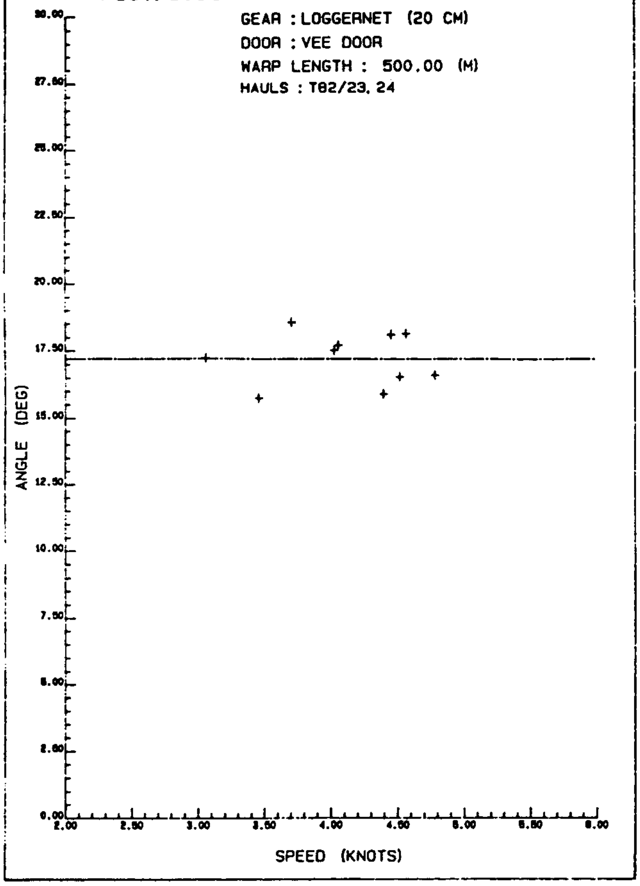


FIG.: 9.12 SWEEP DIVERGENCE VS. SPEED

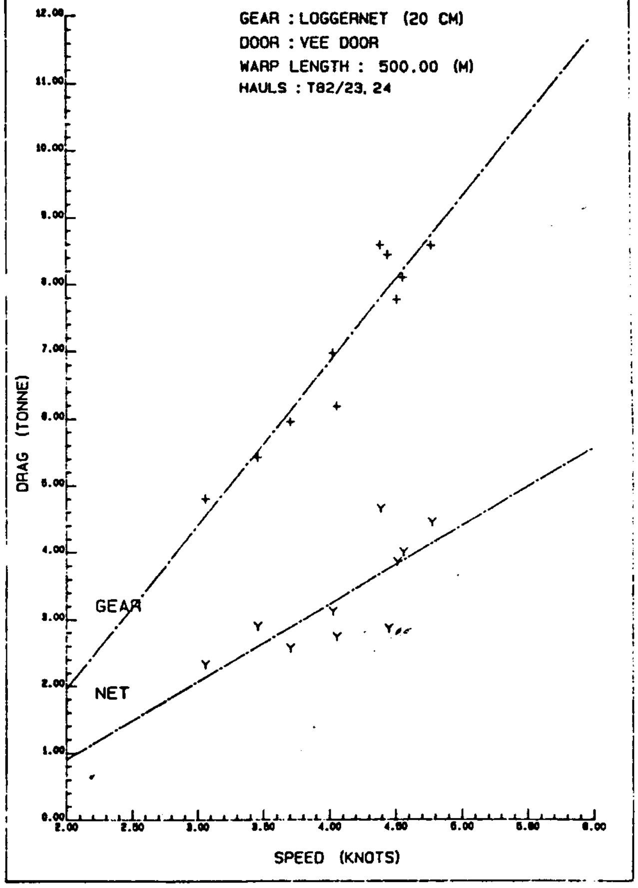


FIG.: 10.12 DRAGS VS. SPEED

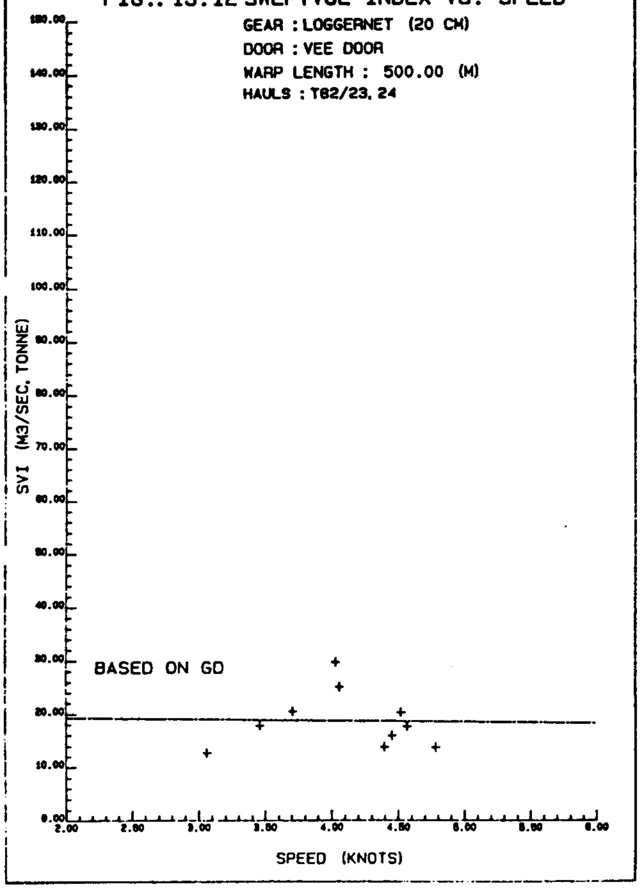


FIG.: 13.12 SWEPTVOL INDEX VS. SPEED

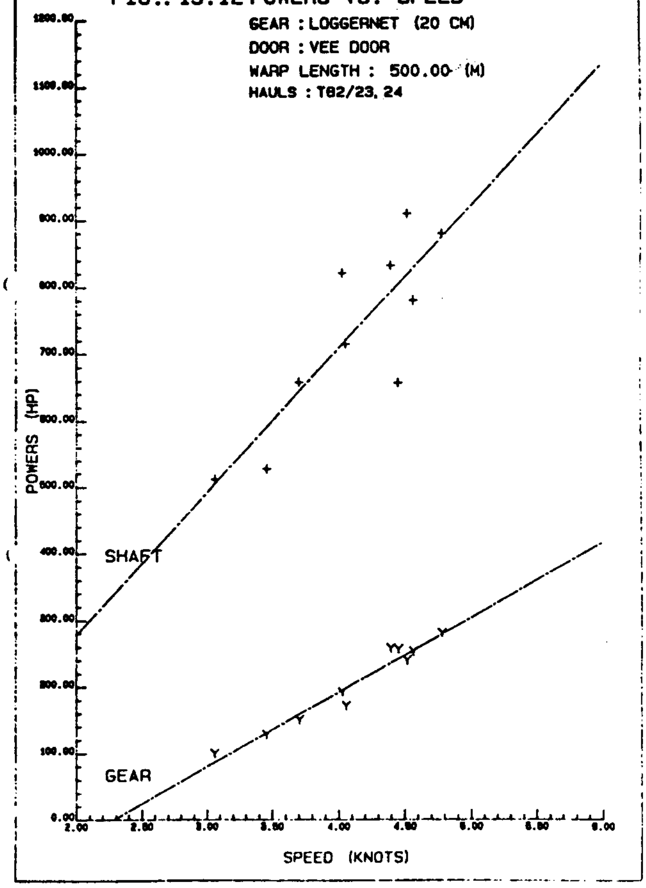


FIG.: 15.12 POWERS VS. SPEED

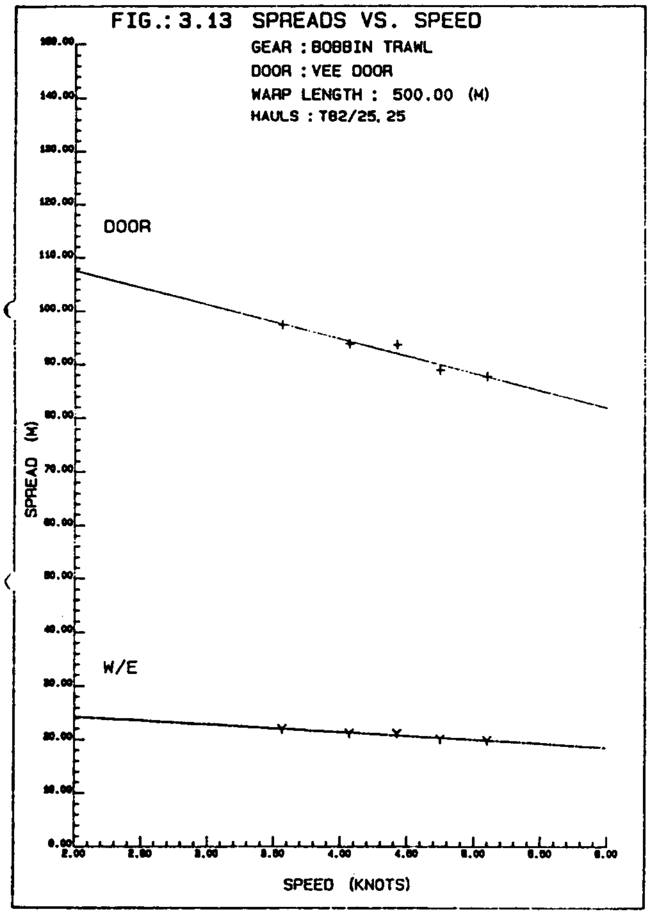


FIG.: 3.13 SPREADS VS. SPEED
GEAR : BOBBIN TRAWL
DOOR : VEE DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/25, 25
DOOR
W/E
SPREAD (M)
SPEED (KNOTS)

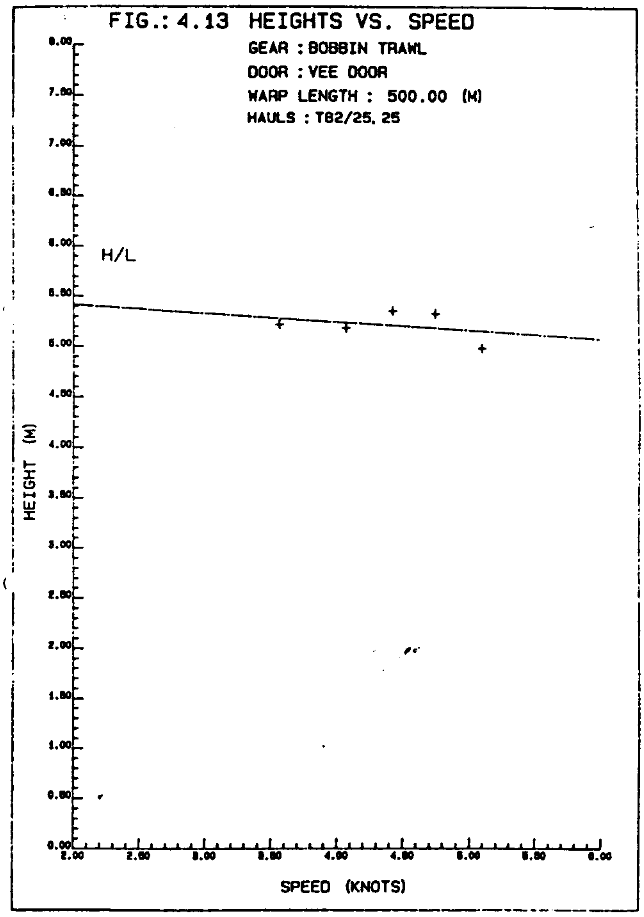


FIG.: 4.13 HEIGHTS VS. SPEED
GEAR : BOBBIN TRAWL
DOOR : VEE DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/25, 25
H/L
HEIGHT (M)
SPEED (KNOTS)

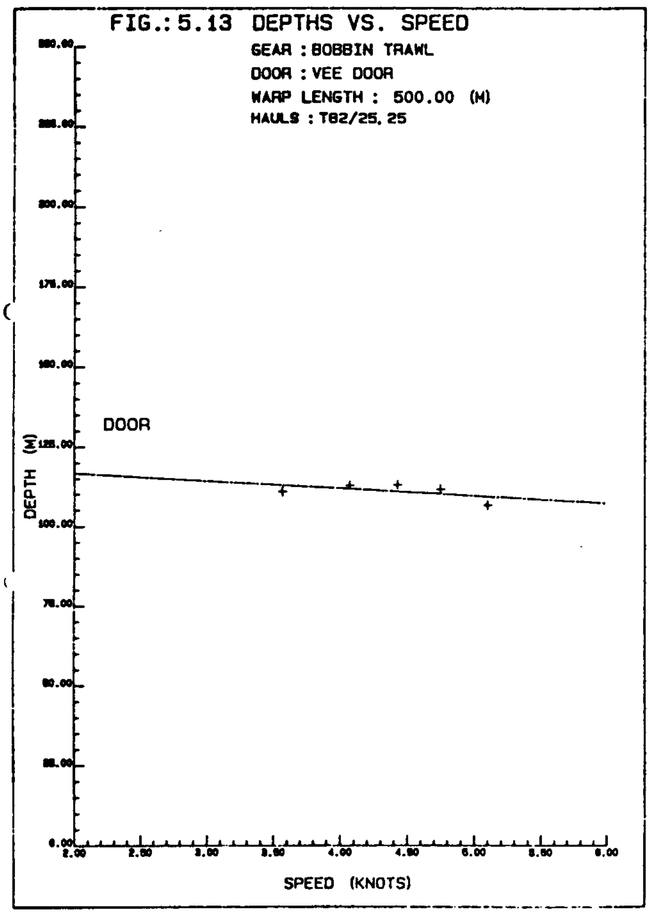


FIG.: 5.13 DEPTHS VS. SPEED
GEAR : BOBBIN TRAWL
DOOR : VEE DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/25, 25
DOOR
DEPTH (M)
SPEED (KNOTS)

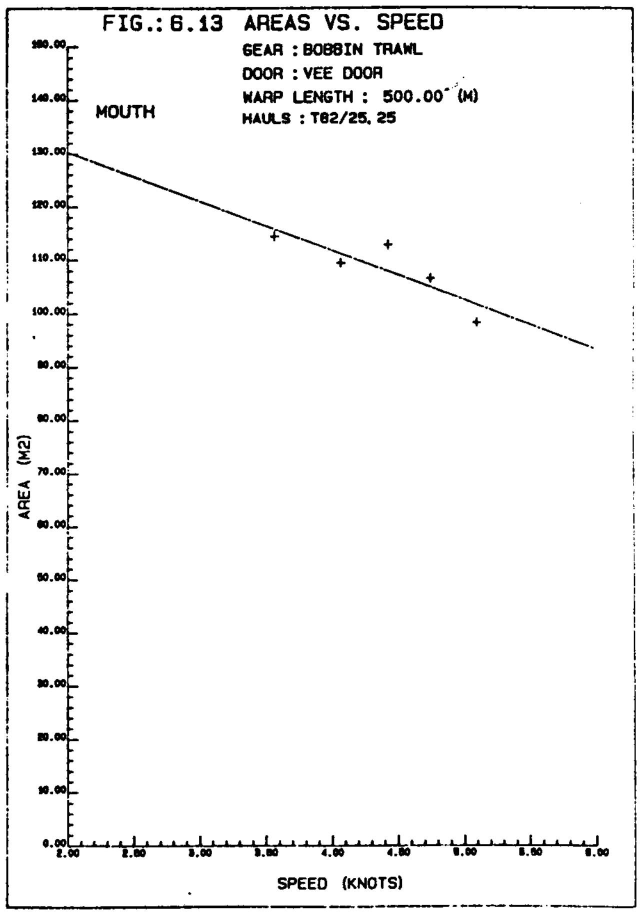


FIG.: 6.13 AREAS VS. SPEED
GEAR : BOBBIN TRAWL
DOOR : VEE DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/25, 25
MOUTH
AREA (M2)
SPEED (KNOTS)

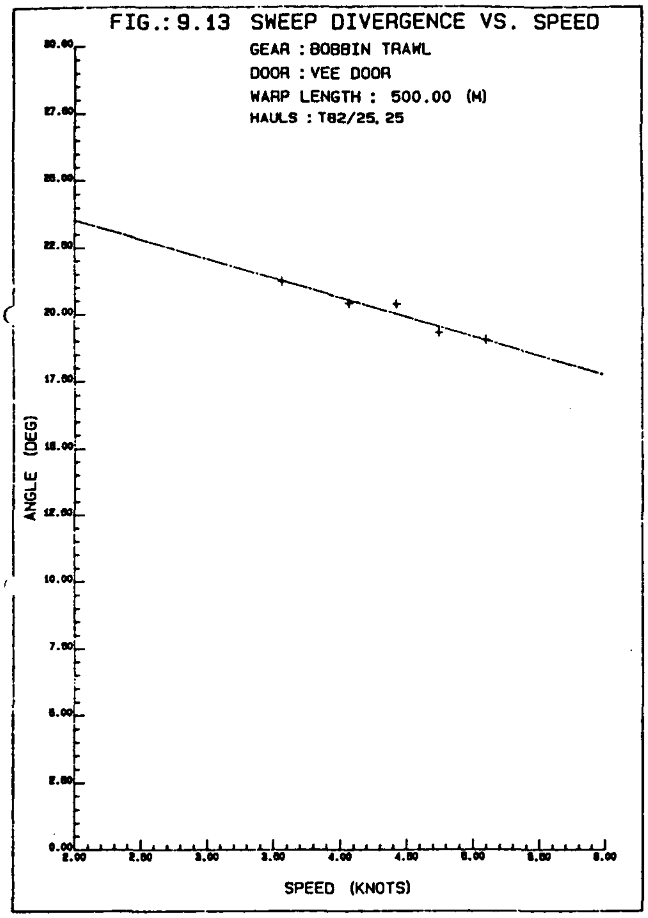


FIG.: 9.13 SWEEP DIVERGENCE VS. SPEED

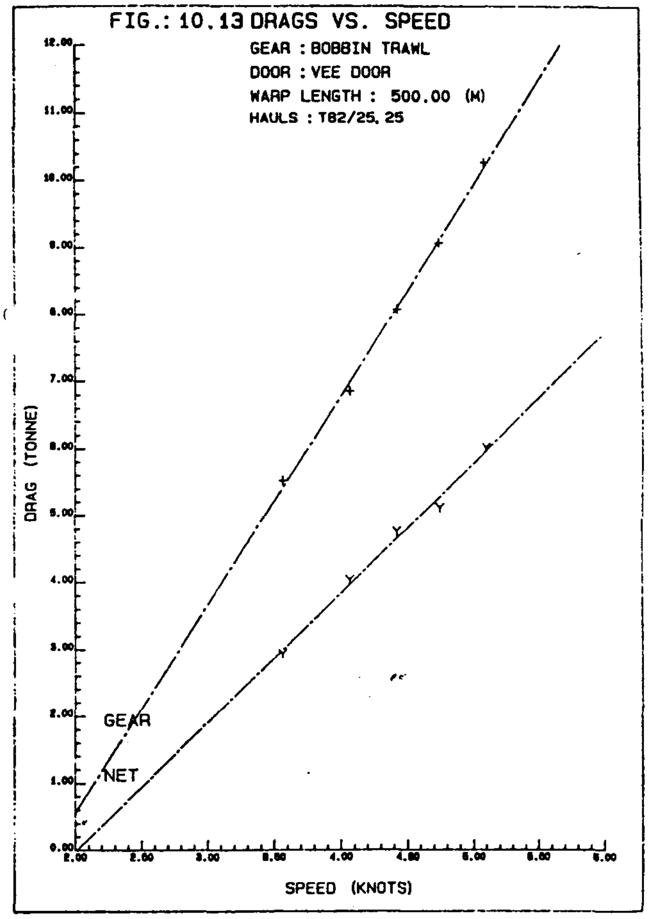


FIG.: 10.13 DRAGS VS. SPEED

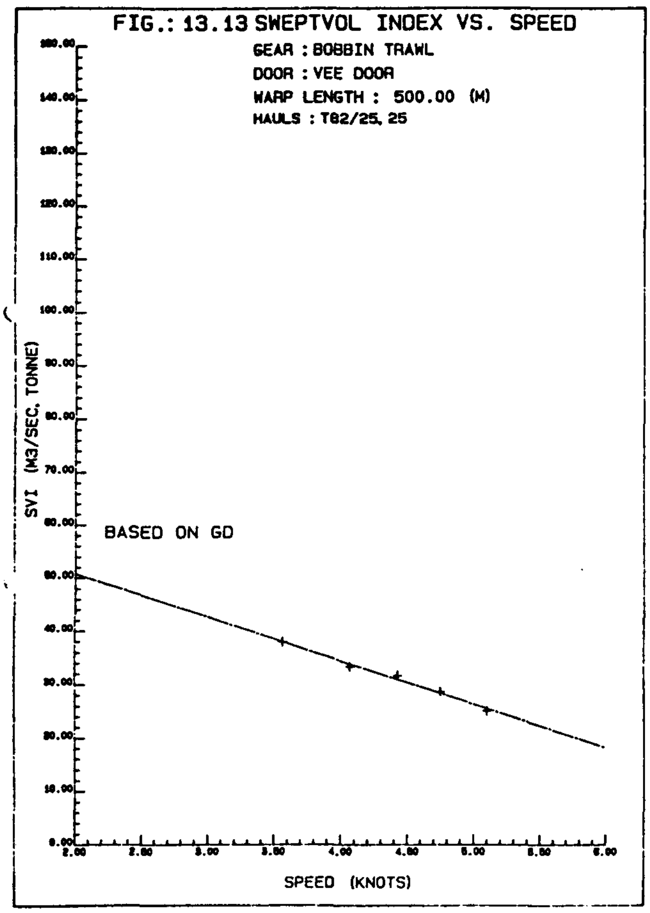


FIG.: 13.13 SWEPTVOL INDEX VS. SPEED

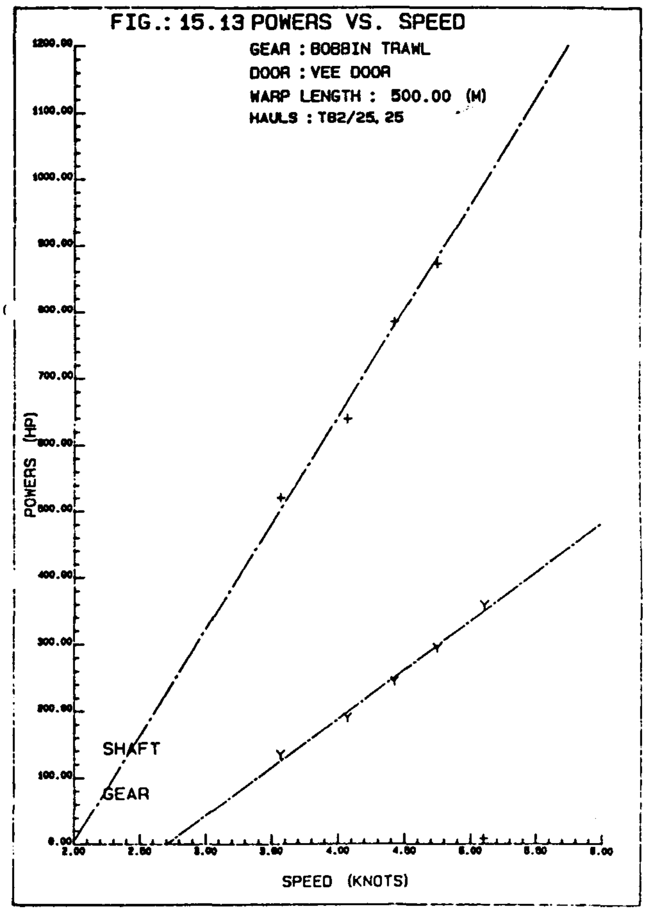


FIG.: 15.13 POWERS VS. SPEED

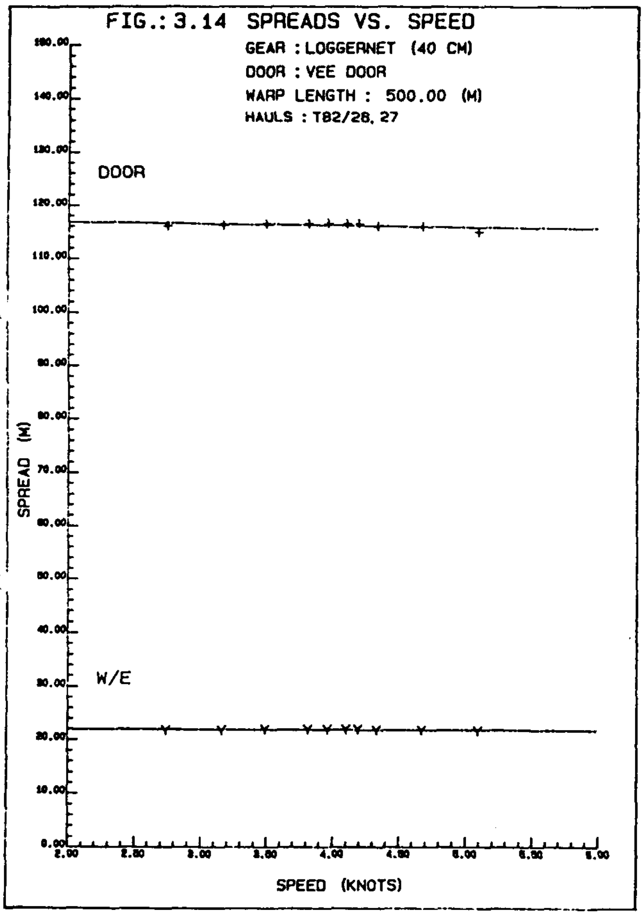


FIG.: 3.14 SPREADS VS. SPEED
GEAR : LOGGERNET (40 CM)
DOOR : VEE DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/26, 27
DOOR
W/E
SPREAD (M)
SPEED (KNOTS)

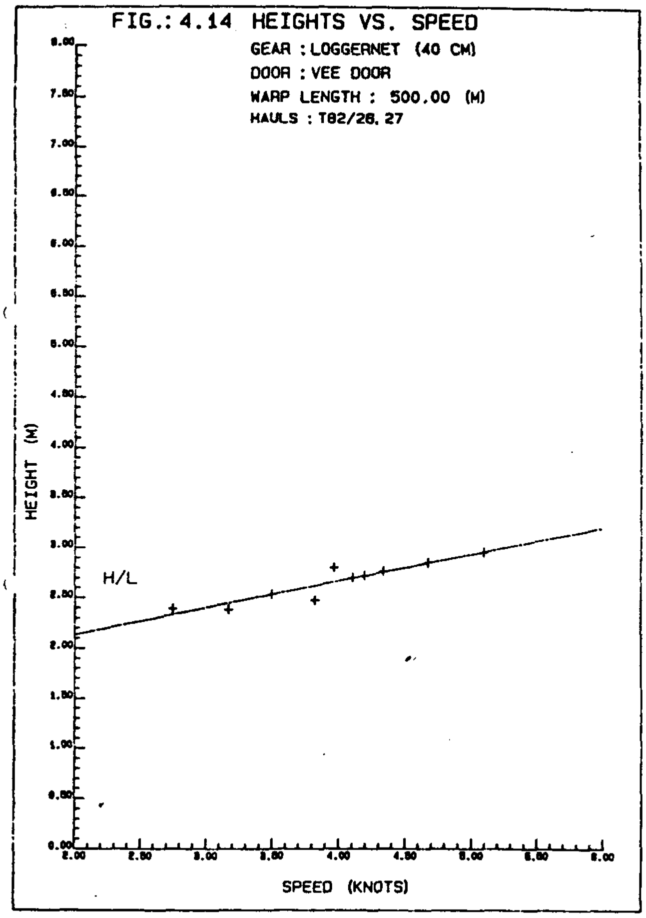


FIG.: 4.14 HEIGHTS VS. SPEED
GEAR : LOGGERNET (40 CM)
DOOR : VEE DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/26, 27
H/L
HEIGHT (M)
SPEED (KNOTS)

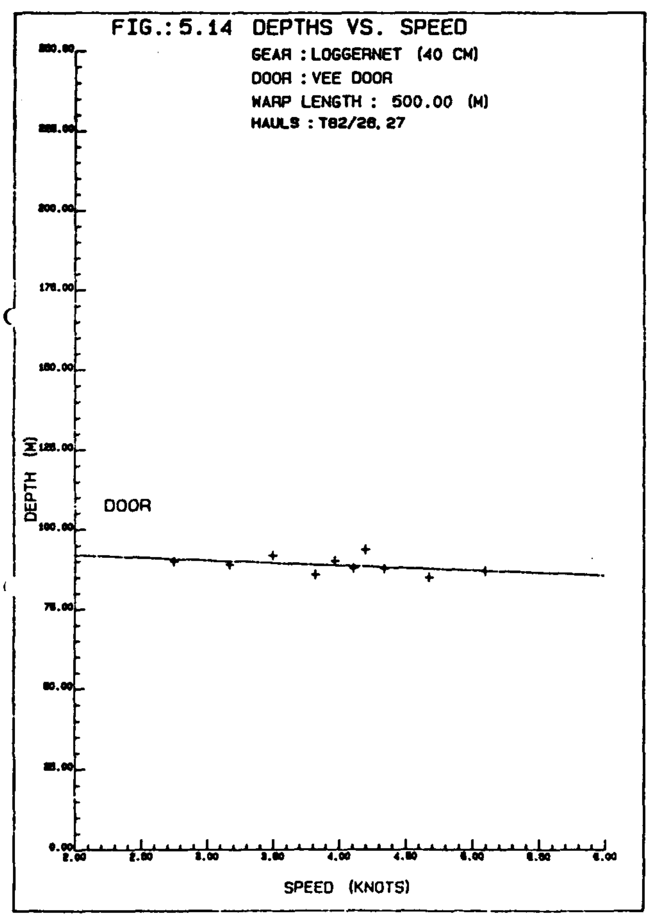


FIG.: 5.14 DEPTHS VS. SPEED
GEAR : LOGGERNET (40 CM)
DOOR : VEE DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/26, 27
DOOR
DEPTH (M)
SPEED (KNOTS)

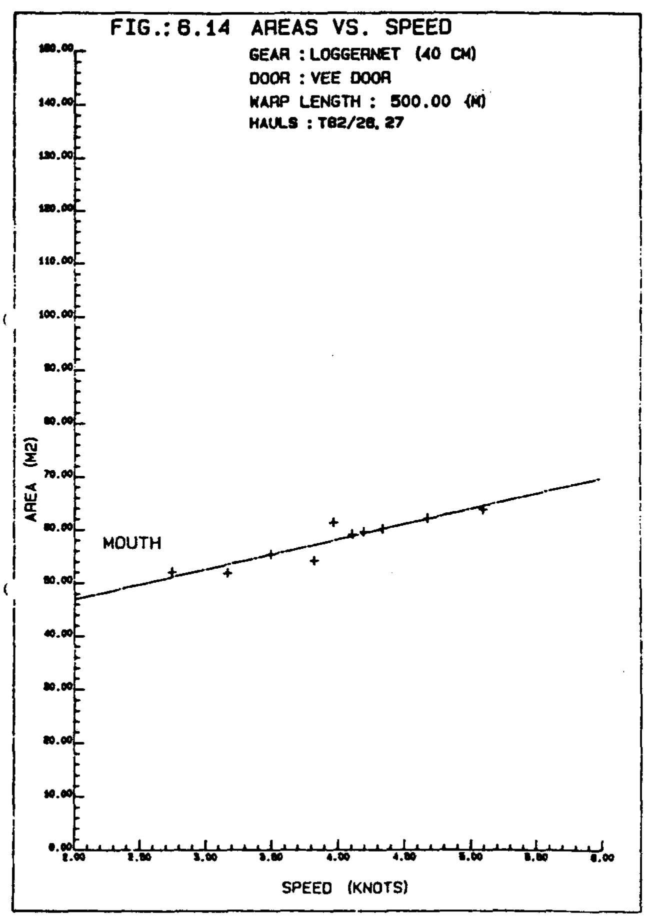


FIG.: 6.14 AREAS VS. SPEED
GEAR : LOGGERNET (40 CM)
DOOR : VEE DOOR
WARP LENGTH : 500.00 (M)
HAULS : T82/26, 27
MOUTH
AREA (M2)
SPEED (KNOTS)

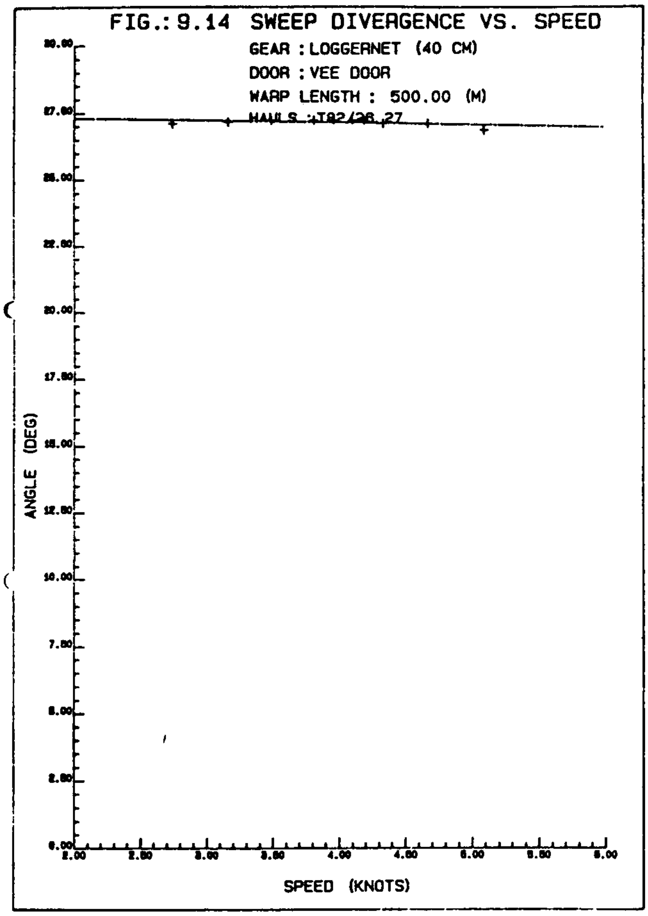


FIG.: 9.14 SWEEP DIVERGENCE VS. SPEED

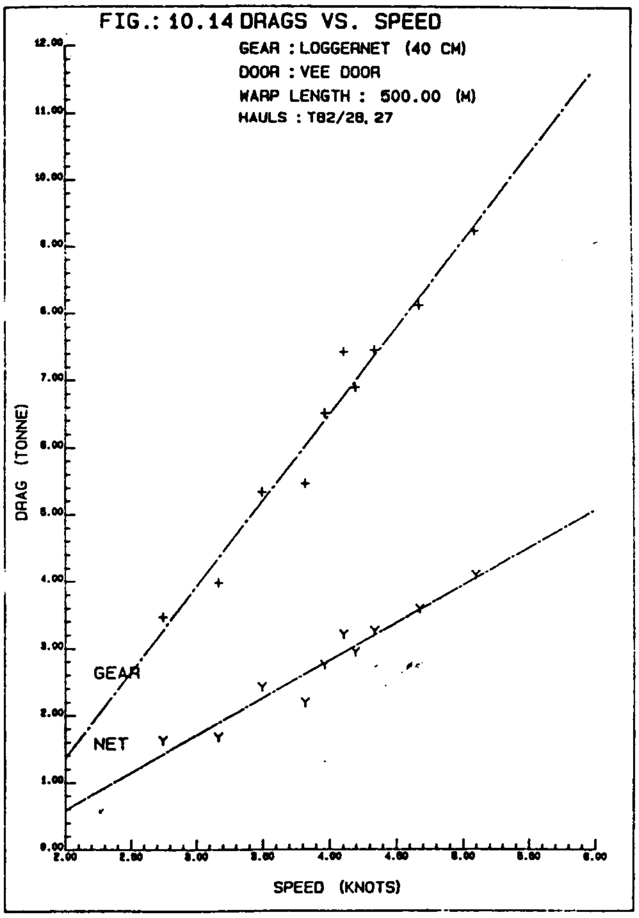


FIG.: 10.14 DRAGS VS. SPEED

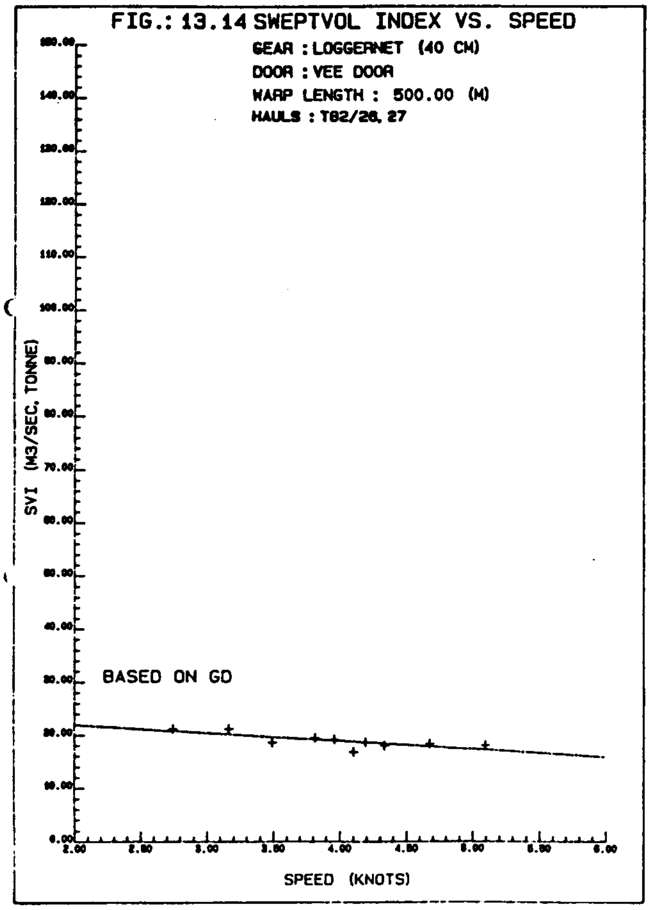


FIG.: 13.14 SWEPTVOL INDEX VS. SPEED

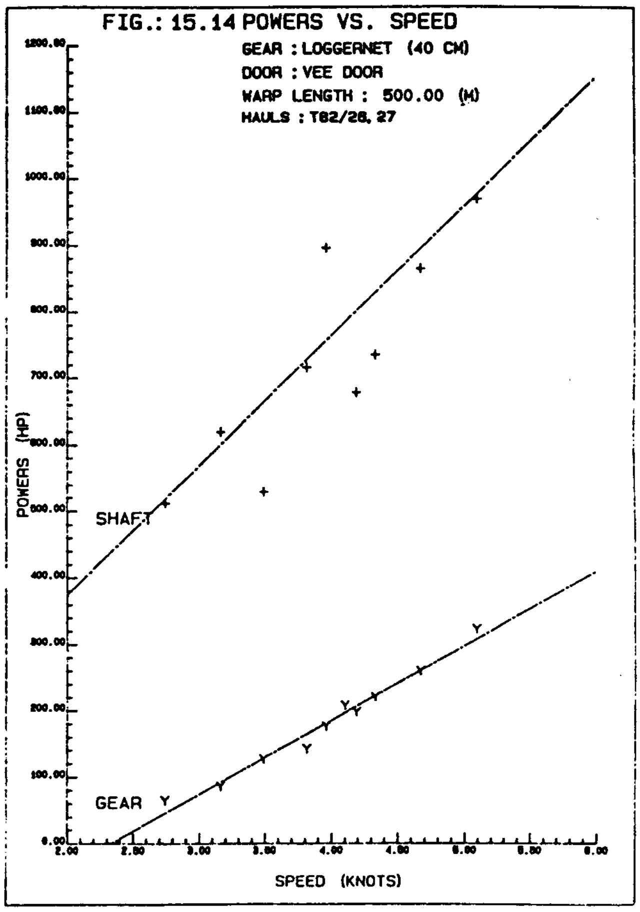


FIG.: 15.14 POWERS VS. SPEED

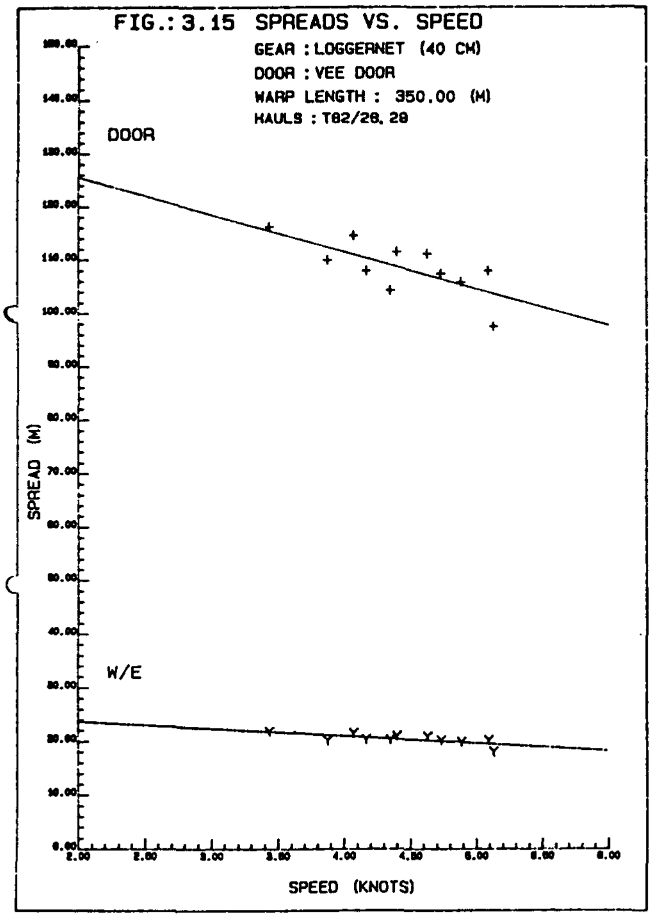


FIG.: 3.15 SPREADS VS. SPEED
GEAR : LOGGERNET (40 CM)
DOOR : VEE DOOR
WARP LENGTH : 350.00 (M)
HAULS : T82/28, 29
DOOR
W/E
SPREAD (M)
SPEED (KNOTS)

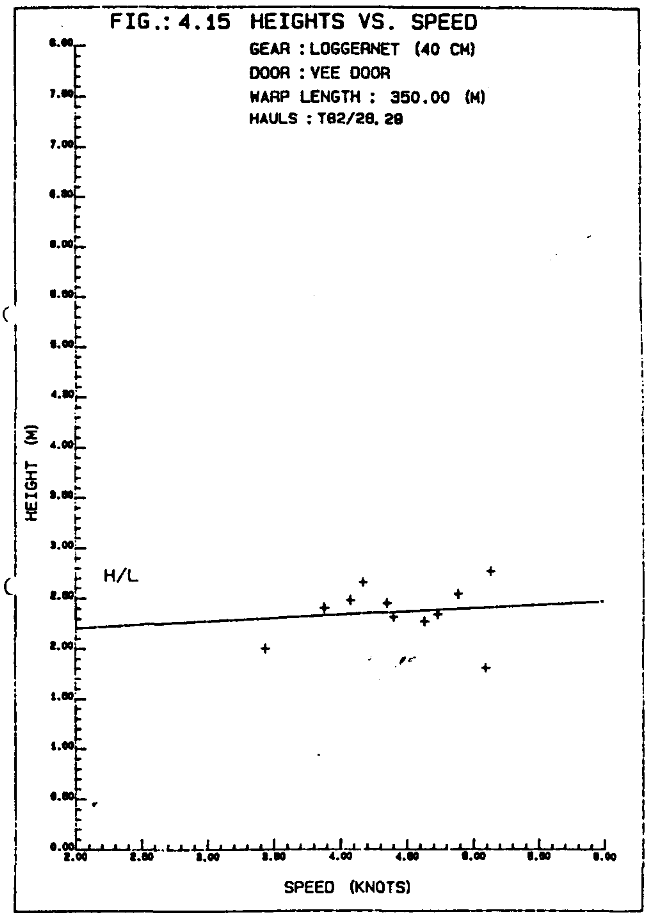


FIG.: 4.15 HEIGHTS VS. SPEED
GEAR : LOGGERNET (40 CM)
DOOR : VEE DOOR
WARP LENGTH : 350.00 (M)
HAULS : T82/28, 29
H/L
HEIGHT (M)
SPEED (KNOTS)

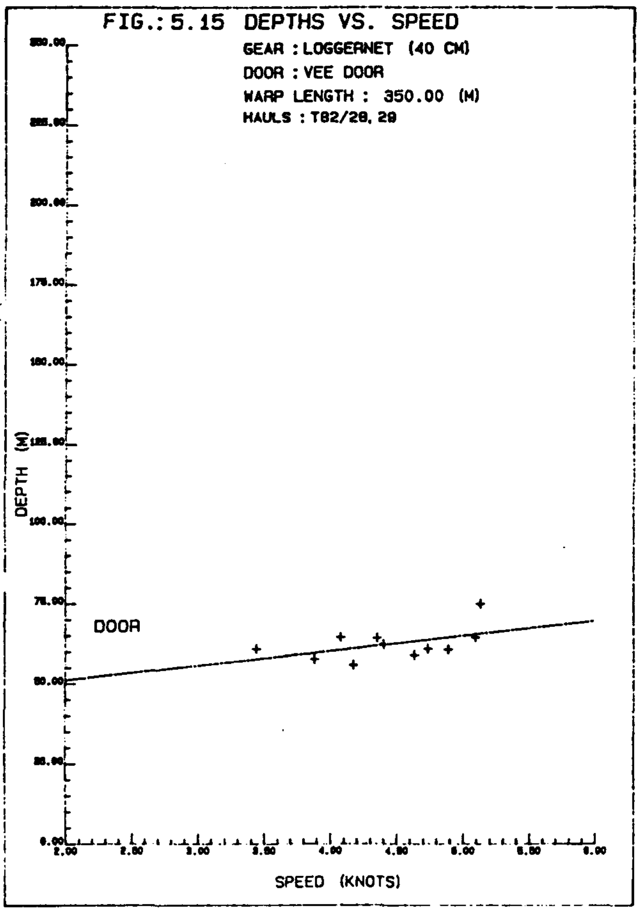


FIG.: 5.15 DEPTHS VS. SPEED
GEAR : LOGGERNET (40 CM)
DOOR : VEE DOOR
WARP LENGTH : 350.00 (M)
HAULS : T82/28, 29
DOOR
DEPTH (M)
SPEED (KNOTS)

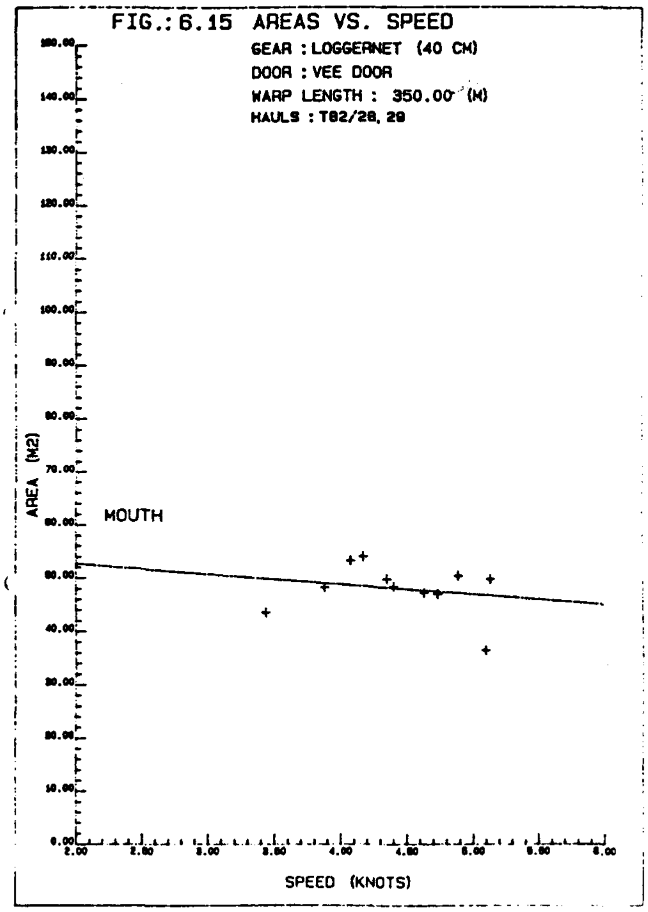


FIG.: 6.15 AREAS VS. SPEED
GEAR : LOGGERNET (40 CM)
DOOR : VEE DOOR
WARP LENGTH : 350.00 (M)
HAULS : T82/28, 29
MOUTH
AREA (M2)
SPEED (KNOTS)

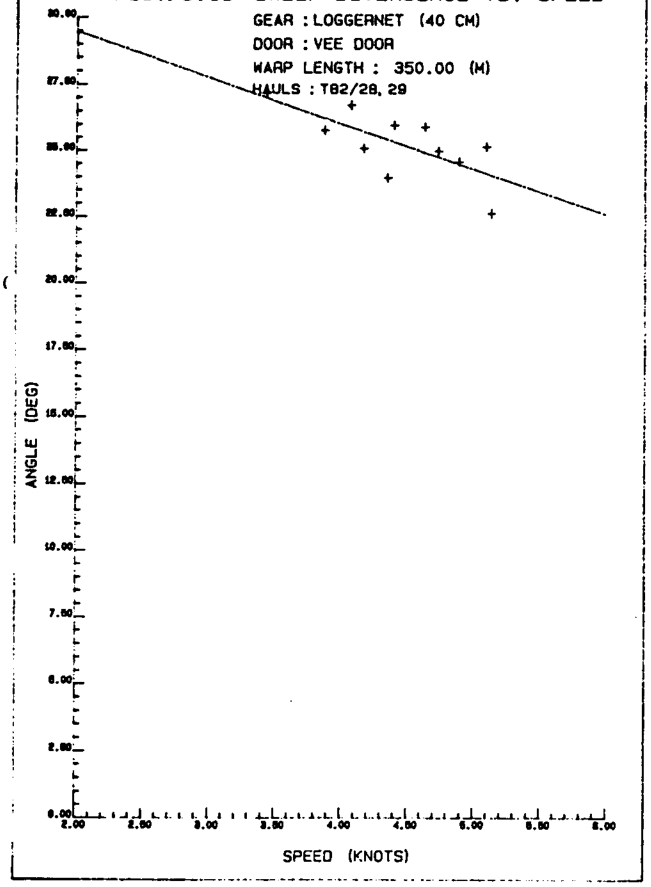


FIG.: 9.15 SWEEP DIVERGENCE VS. SPEED

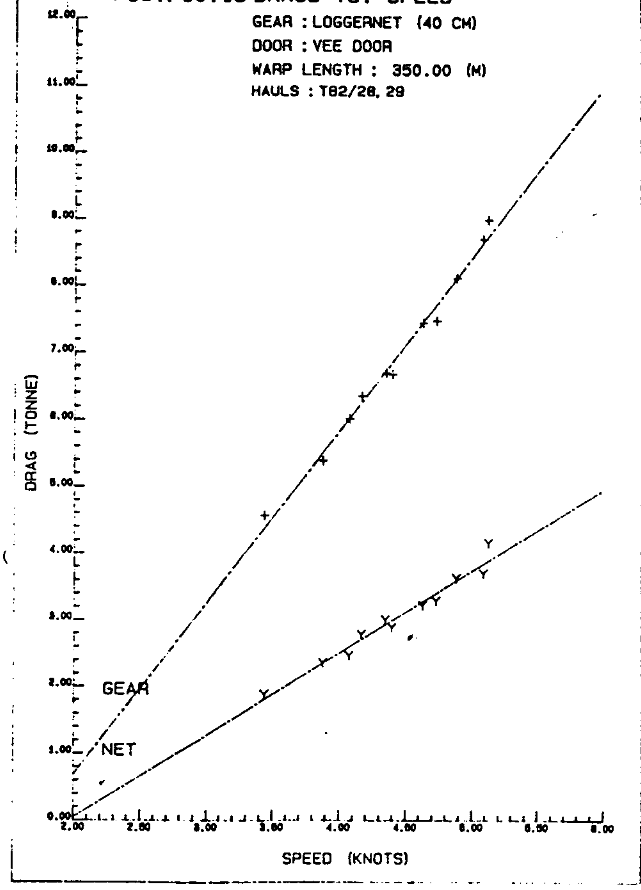


FIG.: 10.15 DRAGS VS. SPEED

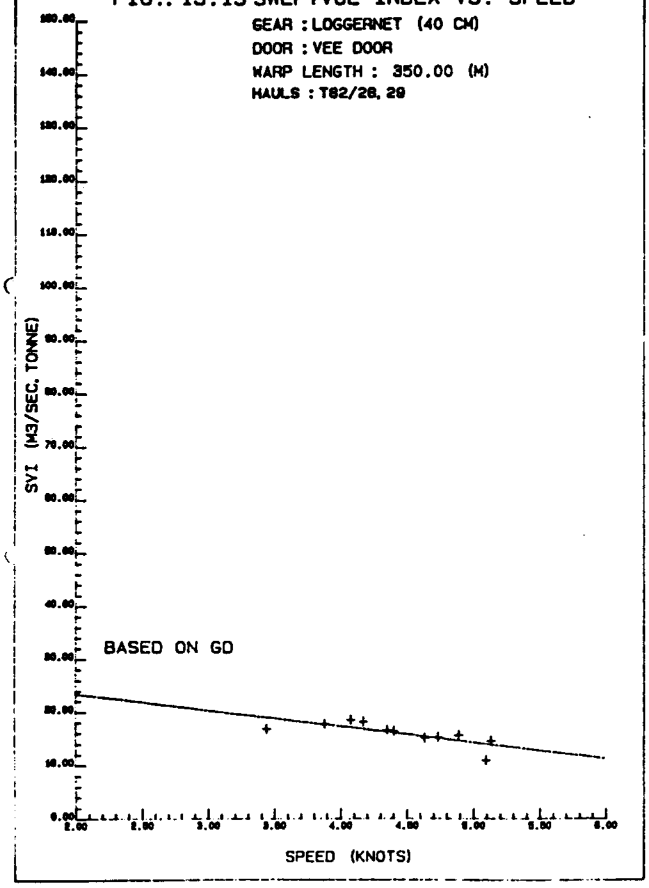


FIG.: 13.15 SWEPTVOL INDEX VS. SPEED

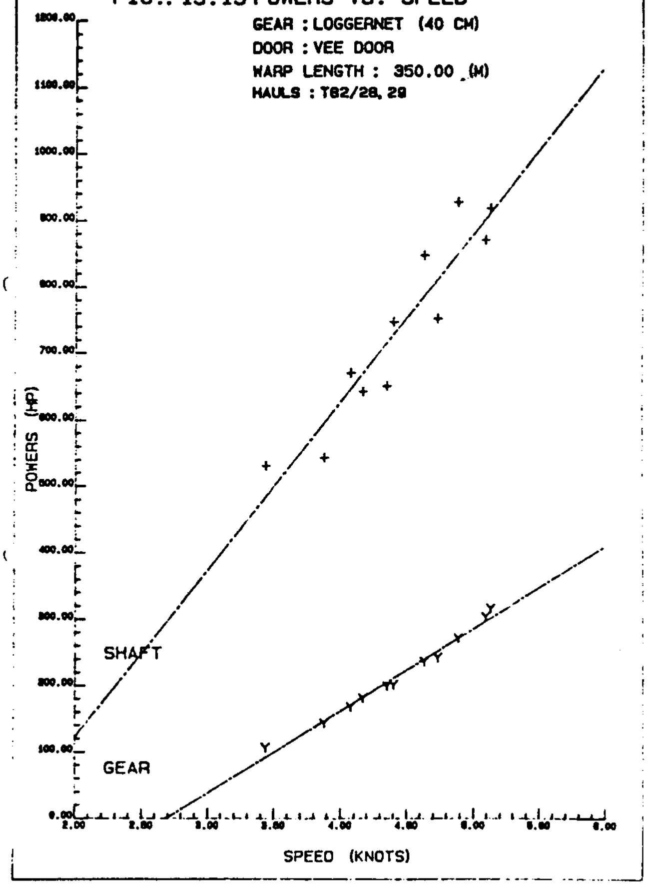


FIG.: 15.15 POWERS VS. SPEED

FIG.: 9.16 SWEEP DIVERGENCE VS. SPEED

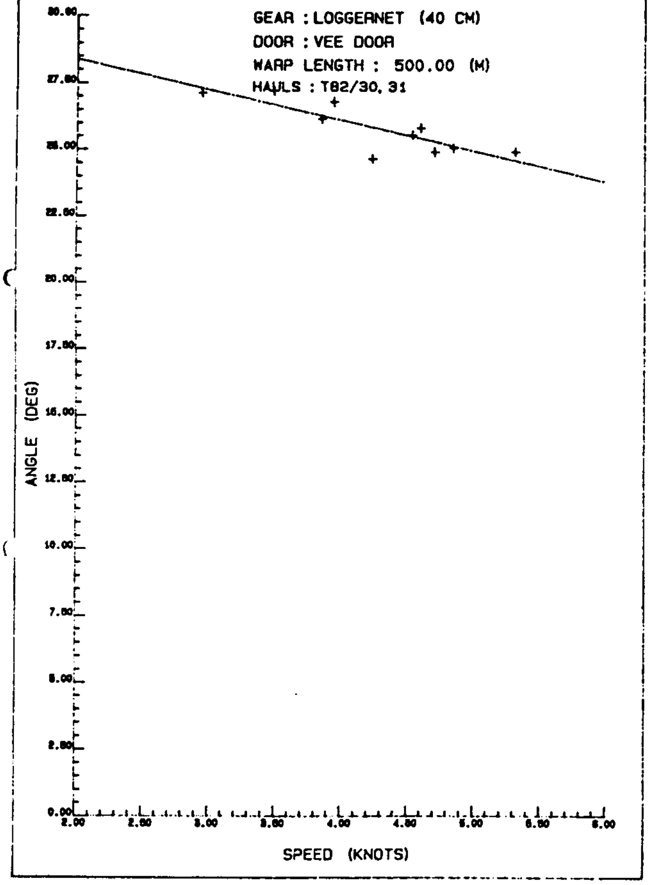


FIG.: 10.16 DRAGS VS. SPEED

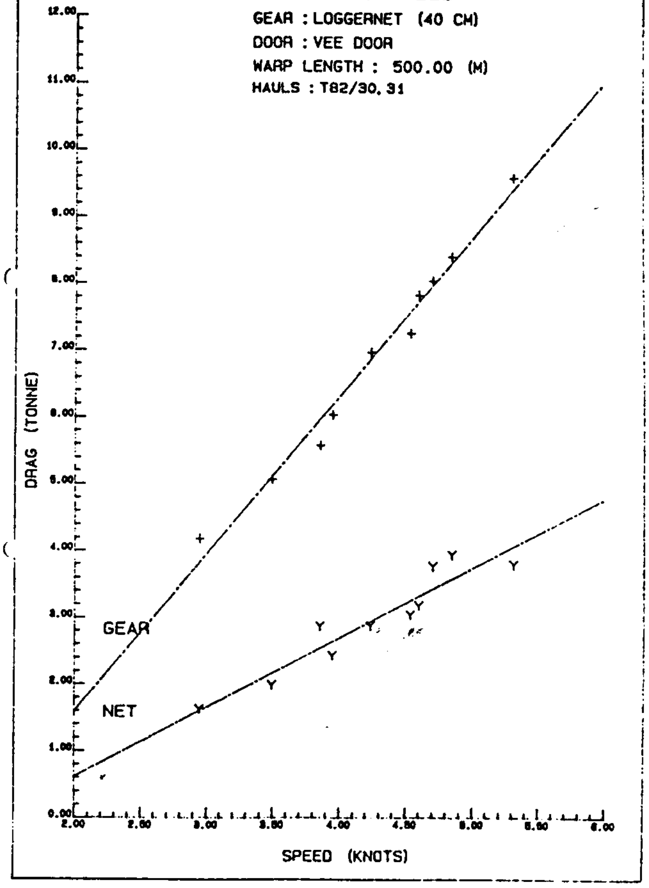


FIG.: 13.16 SWEPTVOL INDEX VS. SPEED

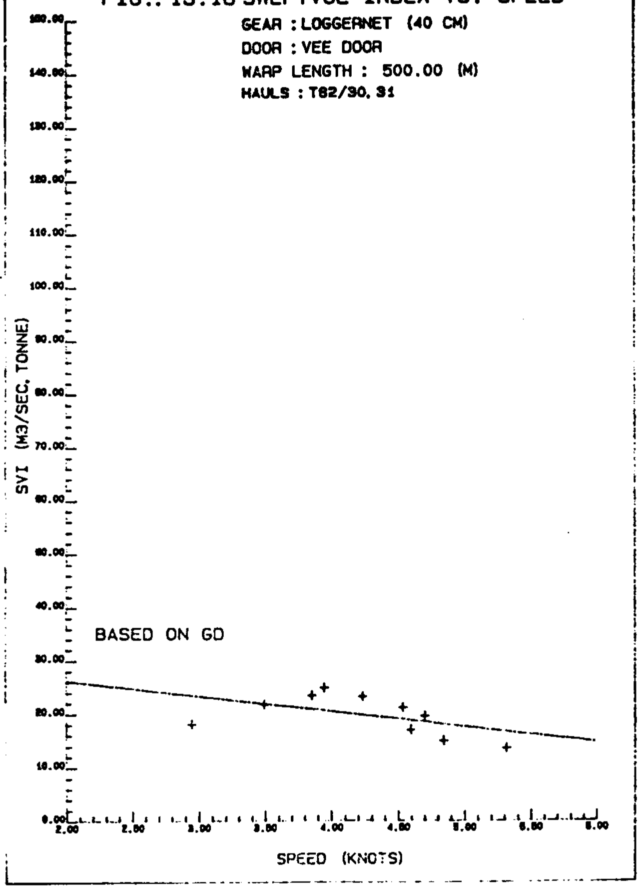
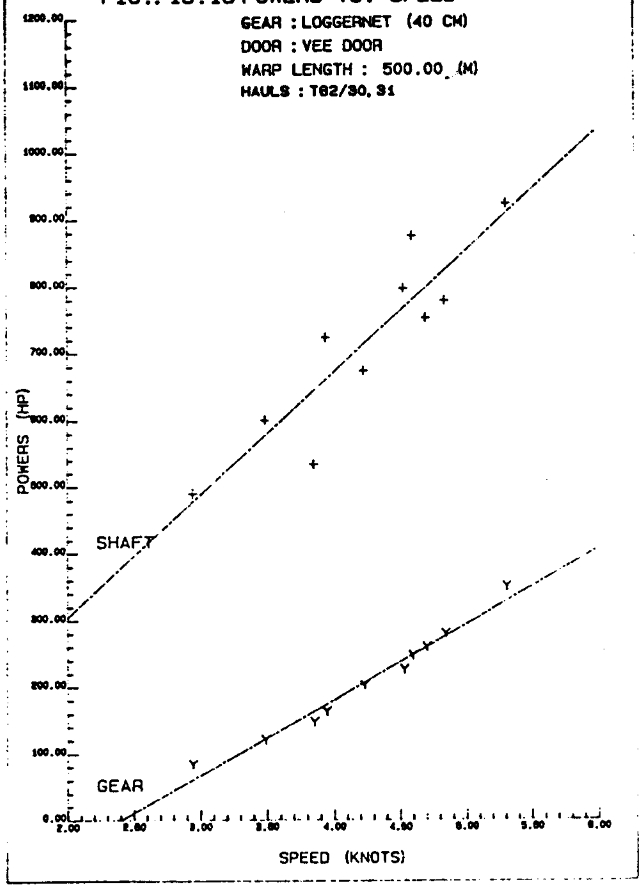


FIG.: 15.16 POWERS VS. SPEED



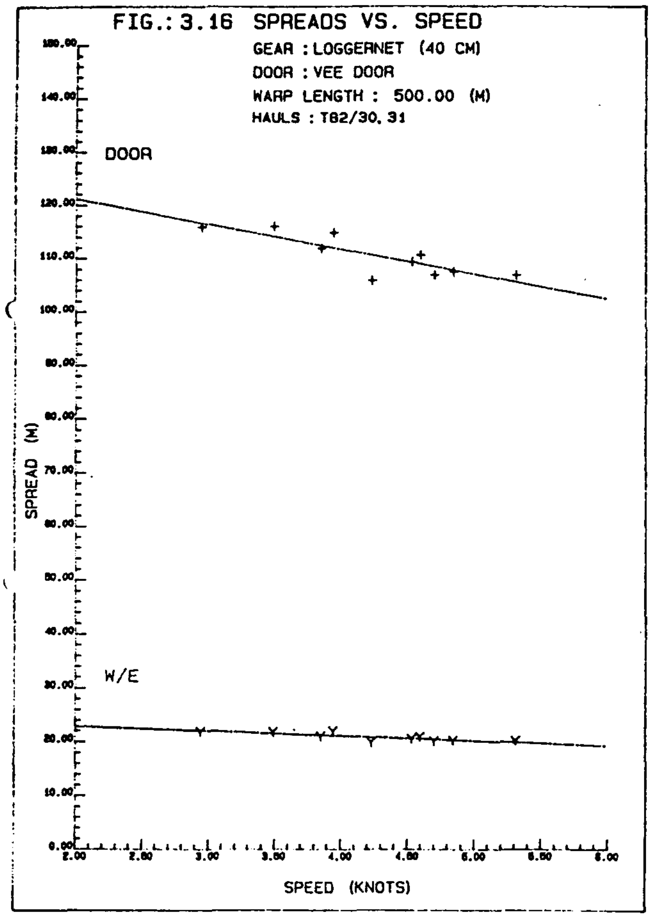


FIG.: 3.16 SPREADS VS. SPEED

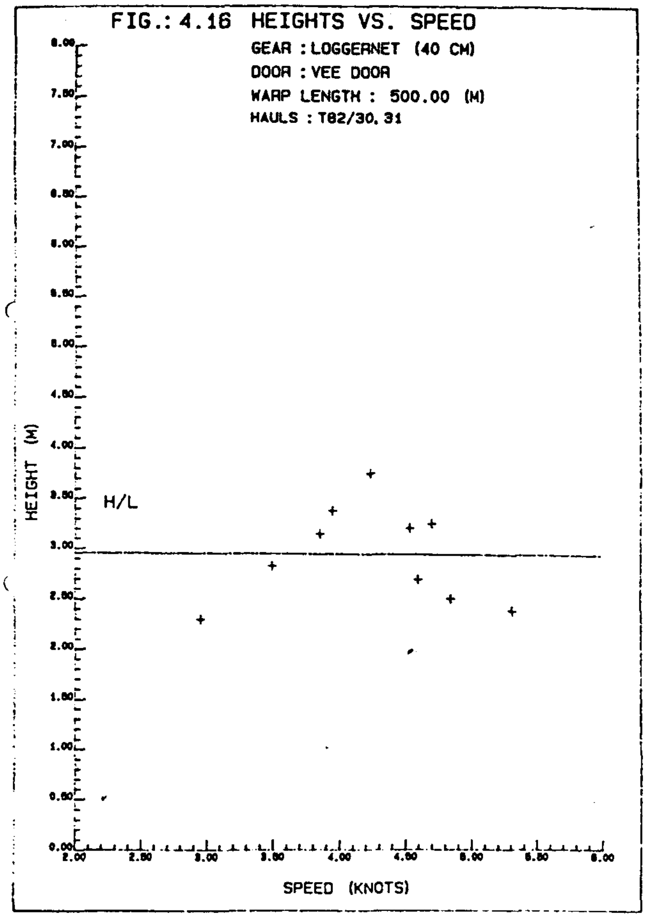


FIG.: 4.16 HEIGHTS VS. SPEED

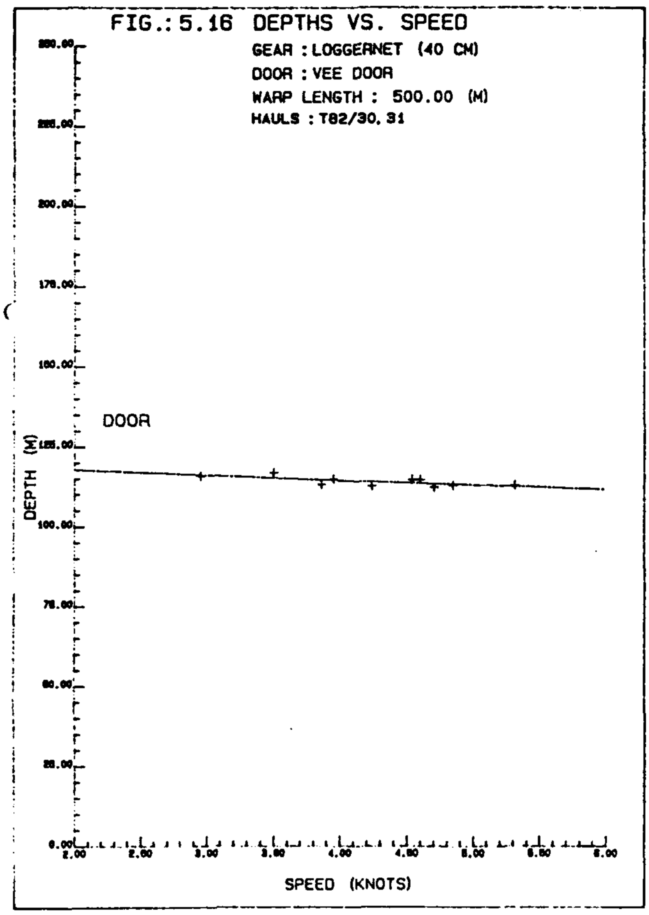


FIG.: 5.16 DEPTHS VS. SPEED

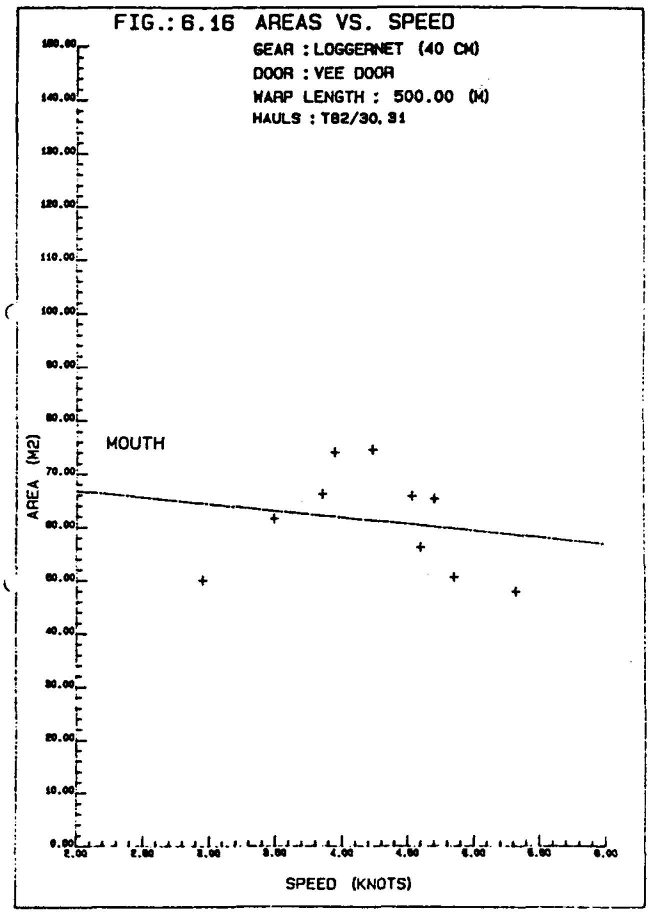


FIG.: 6.16 AREAS VS. SPEED

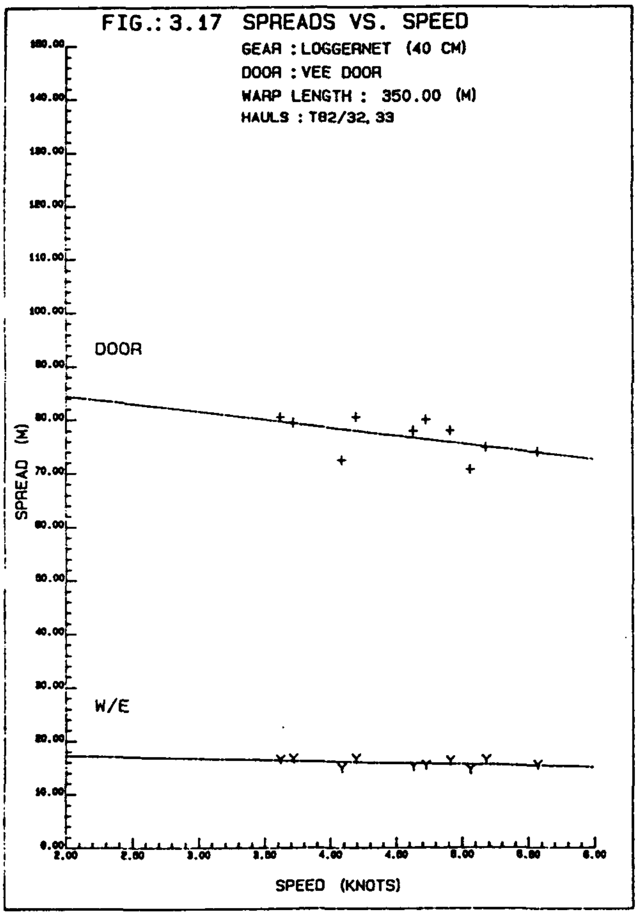


FIG.: 3.17 SPREADS VS. SPEED
GEAR : LOGGERNET (40 CM)
DOOR : VEE DOOR
WARP LENGTH : 350.00 (M)
HAULS : T82/32, 33
DOOR
W/E
SPREAD (M)
SPEED (KNOTS)

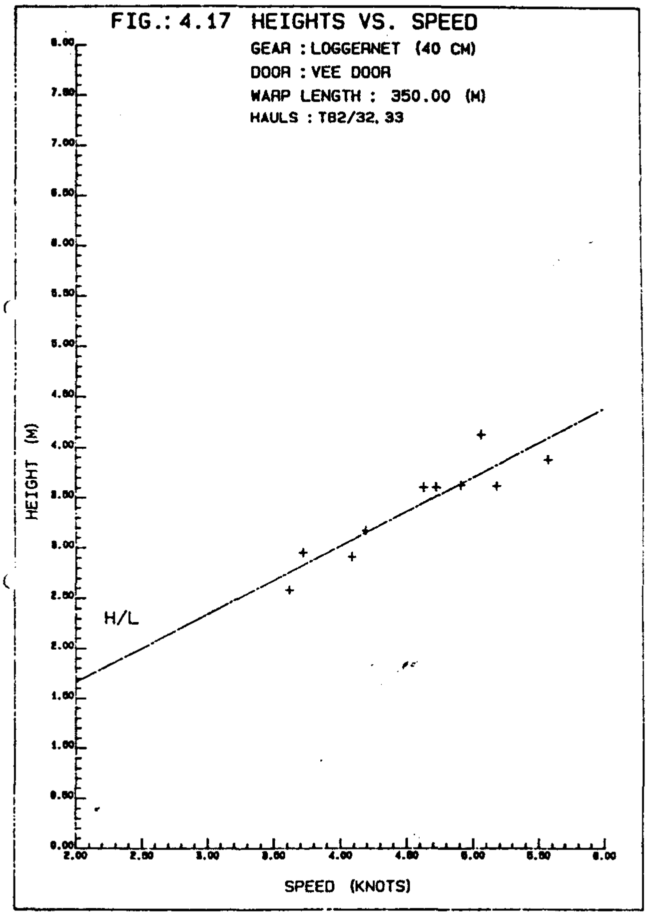


FIG.: 4.17 HEIGHTS VS. SPEED
GEAR : LOGGERNET (40 CM)
DOOR : VEE DOOR
WARP LENGTH : 350.00 (M)
HAULS : T82/32, 33
H/L
HEIGHT (M)
SPEED (KNOTS)

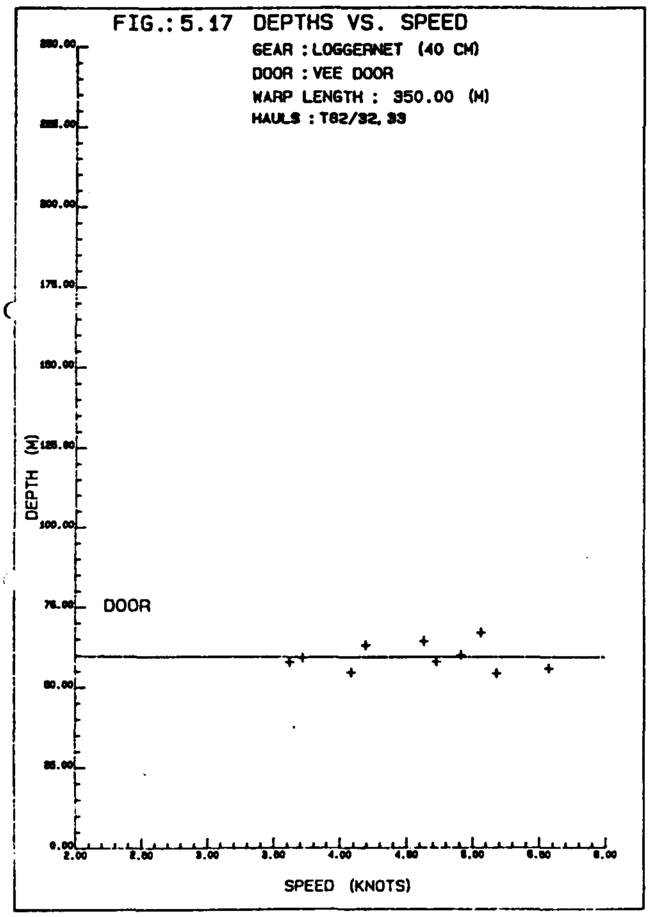


FIG.: 5.17 DEPTHS VS. SPEED
GEAR : LOGGERNET (40 CM)
DOOR : VEE DOOR
WARP LENGTH : 350.00 (M)
HAULS : T82/32, 33
DOOR
DEPTH (M)
SPEED (KNOTS)

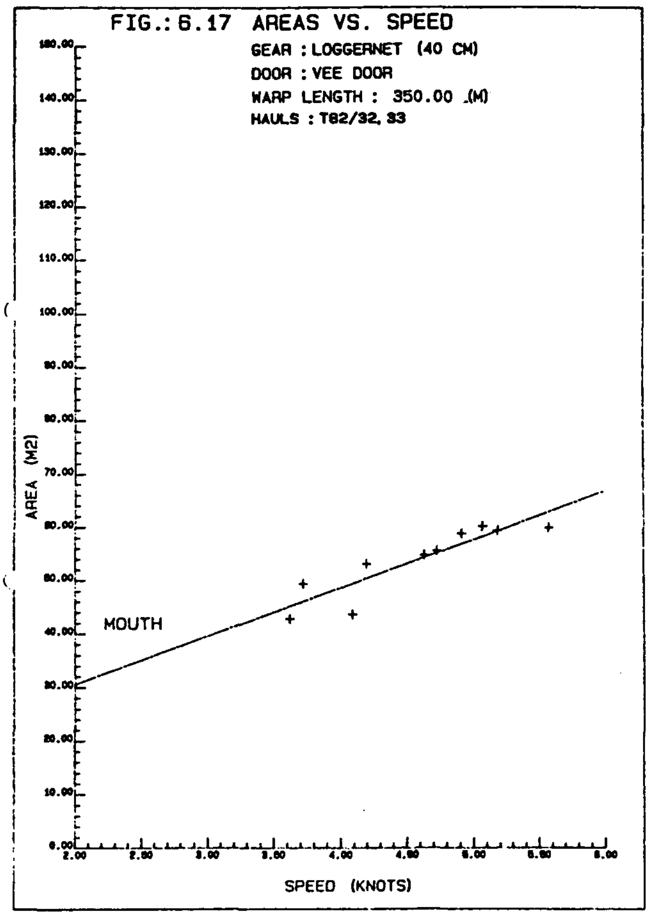


FIG.: 6.17 AREAS VS. SPEED
GEAR : LOGGERNET (40 CM)
DOOR : VEE DOOR
WARP LENGTH : 350.00 (M)
HAULS : T82/32, 33
MOUTH
AREA (M2)
SPEED (KNOTS)

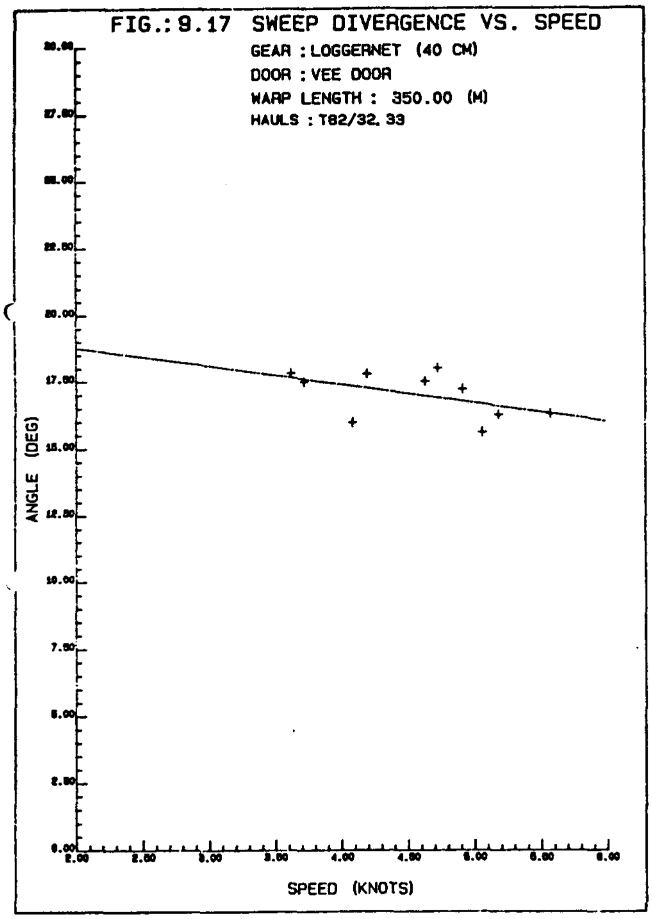


FIG.: 9.17 SWEEP DIVERGENCE VS. SPEED
GEAR : LOGGERNET (40 CM)
DOOR : VEE DOOR
WARP LENGTH : 350.00 (M)
HAULS : T82/32, 33
ANGLE (DEG)
SPEED (KNOTS)

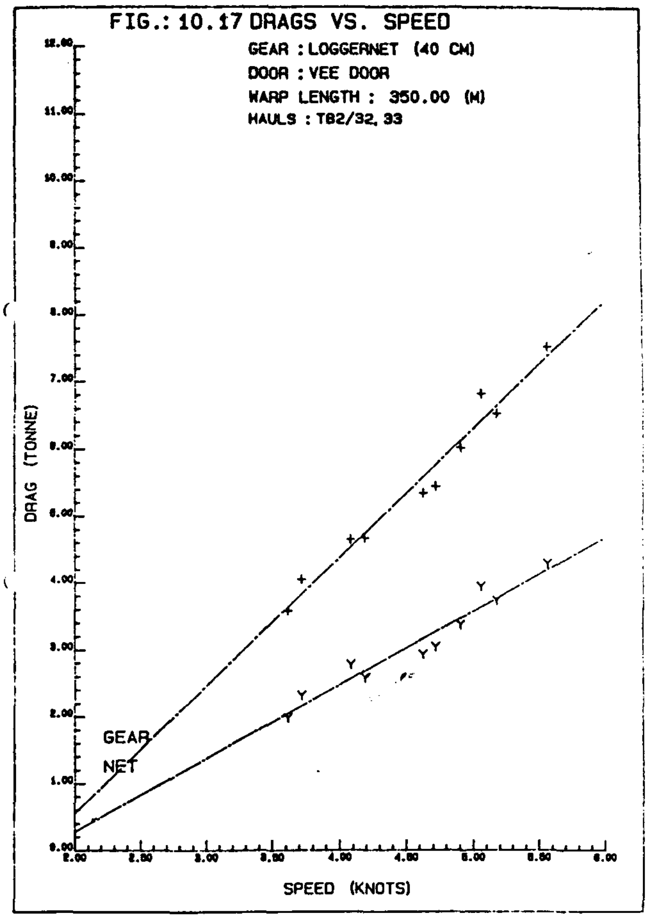


FIG.: 10.17 DRAGS VS. SPEED
GEAR : LOGGERNET (40 CM)
DOOR : VEE DOOR
WARP LENGTH : 350.00 (M)
HAULS : T82/32, 33
DRAG (TONNE)
GEAR
NET
SPEED (KNOTS)

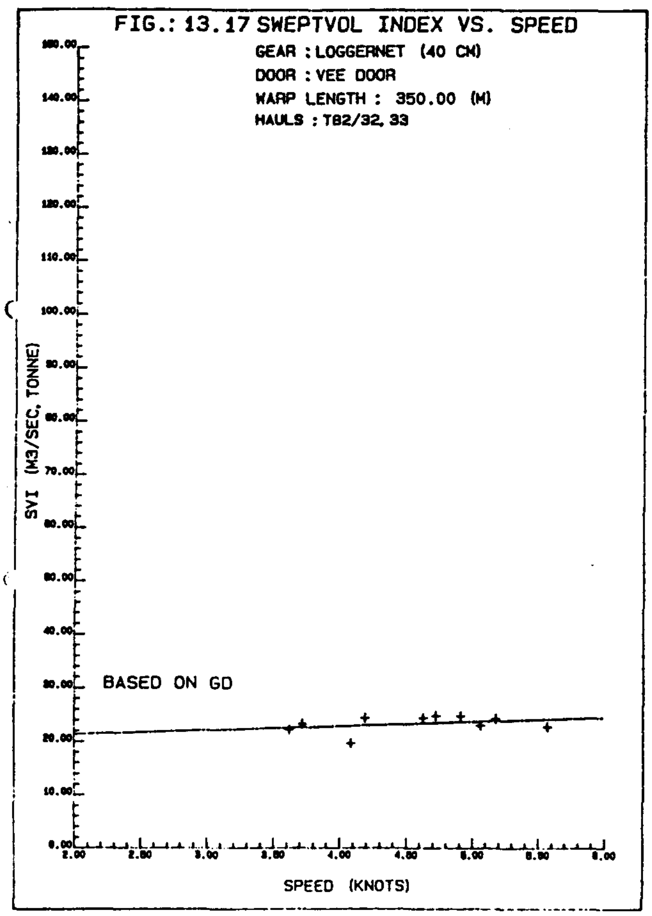


FIG.: 13.17 SWEPTVOL INDEX VS. SPEED
GEAR : LOGGERNET (40 CM)
DOOR : VEE DOOR
WARP LENGTH : 350.00 (M)
HAULS : T82/32, 33
SVI (M3/SEC, TONNE)
BASED ON GD
SPEED (KNOTS)

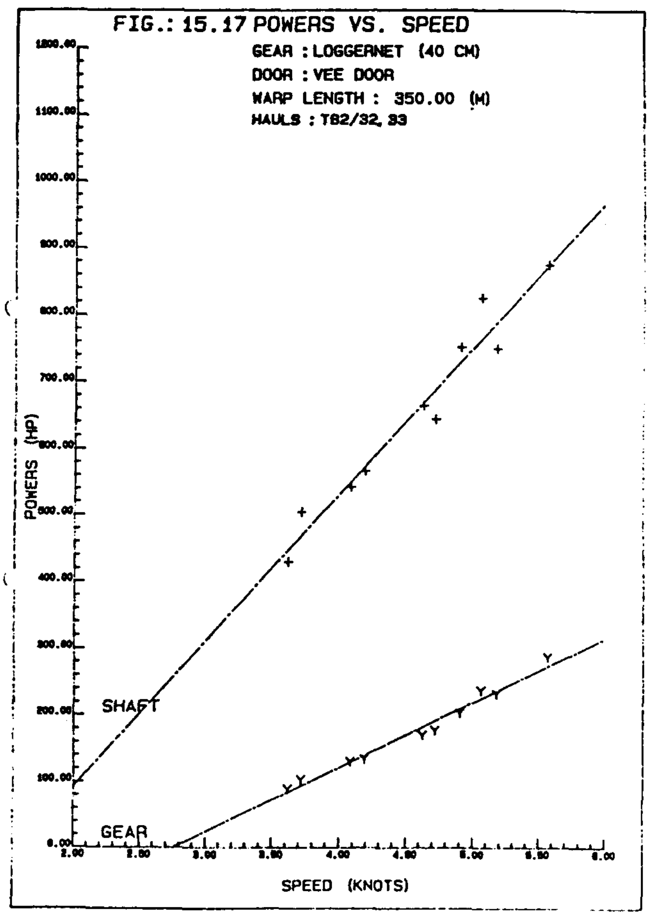


FIG.: 15.17 POWERS VS. SPEED
GEAR : LOGGERNET (40 CM)
DOOR : VEE DOOR
WARP LENGTH : 350.00 (M)
HAULS : T82/32, 33
POWERS (HP)
SHAFT
GEAR
SPEED (KNOTS)

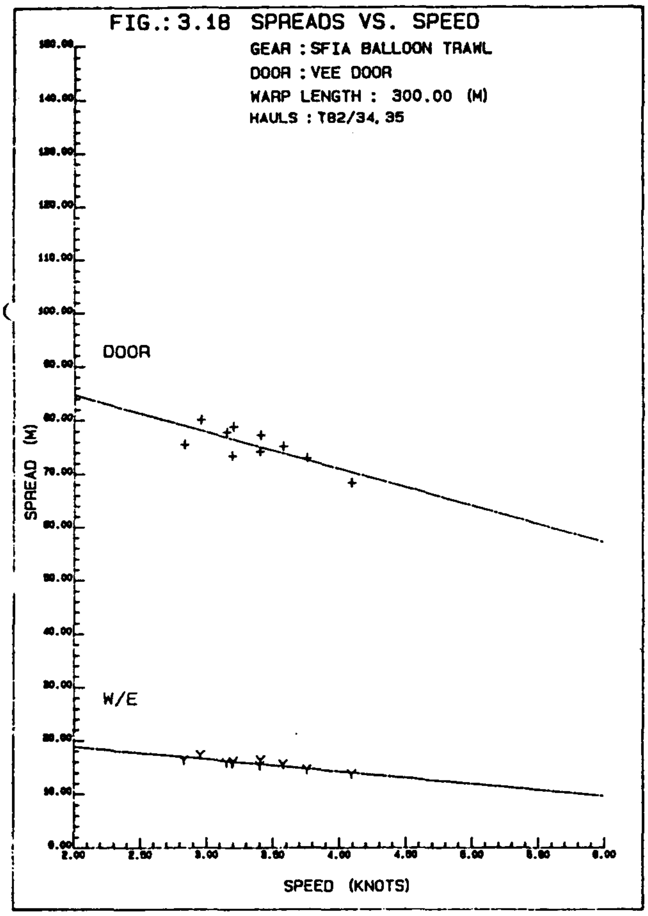


FIG.: 3.18 SPREADS VS. SPEED

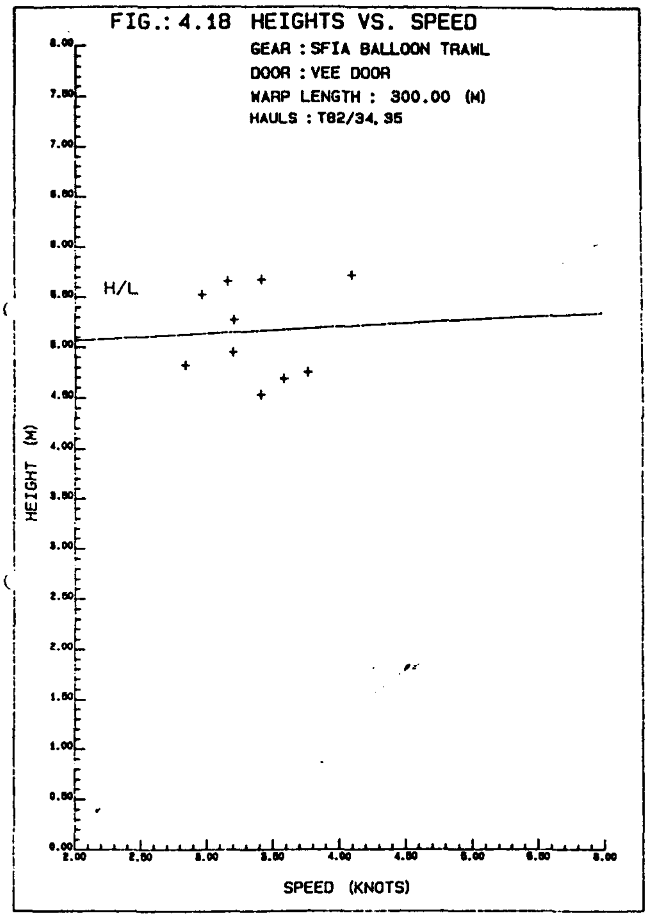


FIG.: 4.18 HEIGHTS VS. SPEED

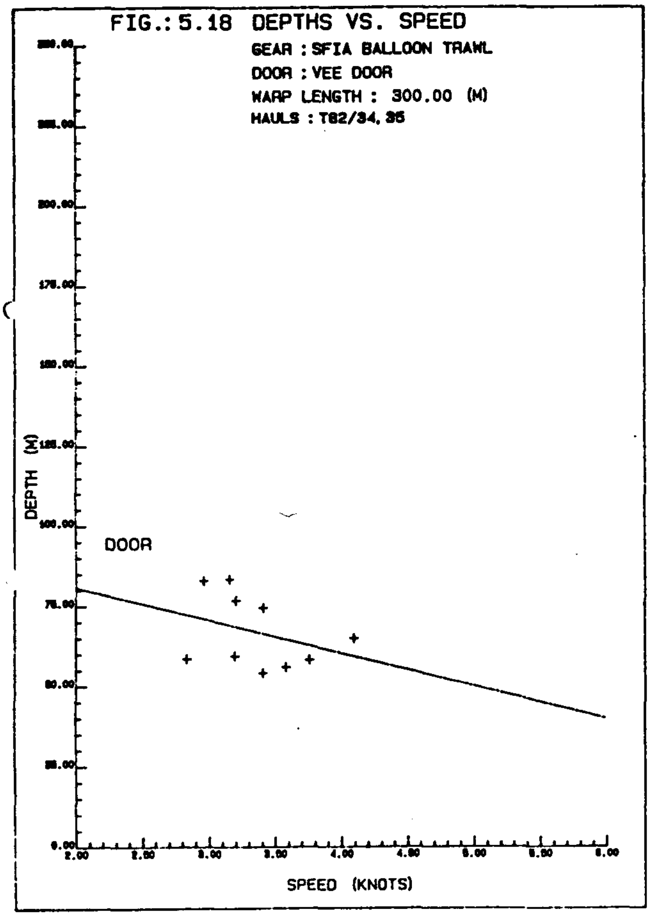


FIG.: 5.18 DEPTHS VS. SPEED

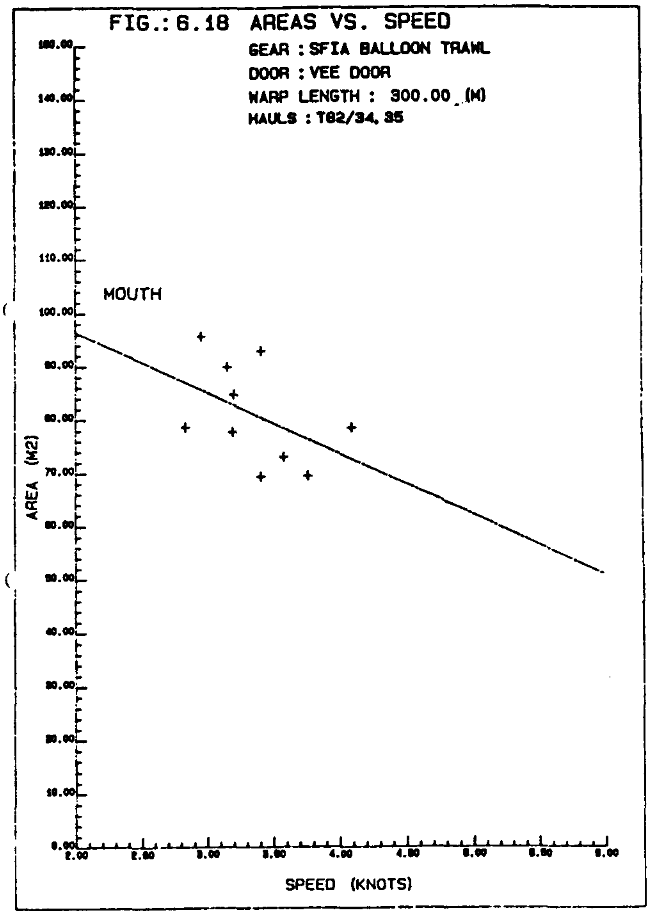


FIG.: 6.18 AREAS VS. SPEED

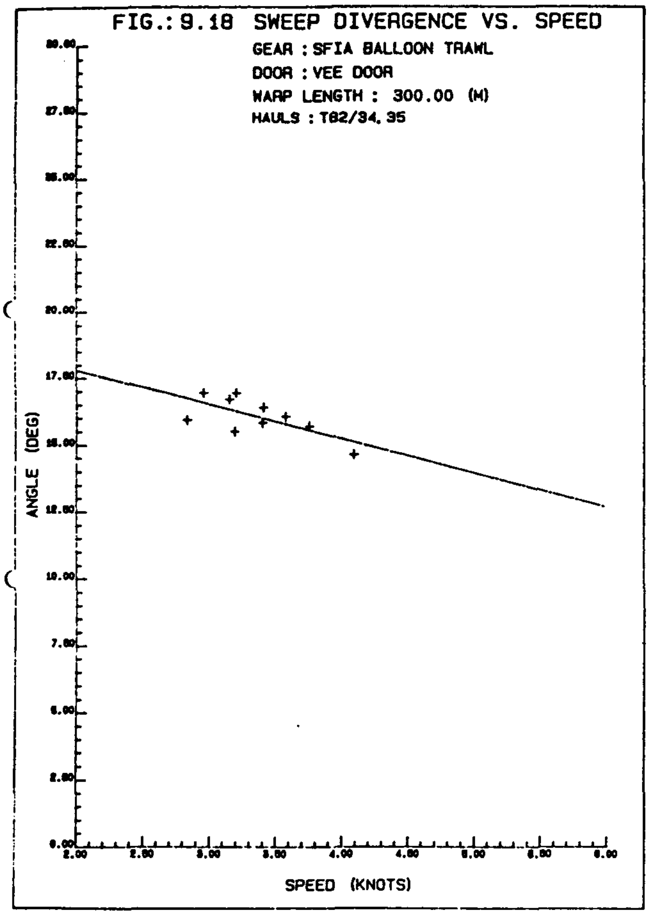


FIG.: 9.18 SWEEP DIVERGENCE VS. SPEED
GEAR : SFIA BALLOON TRAWL
DOOR : VEE DOOR
WARP LENGTH : 300.00 (M)
HAULS : T82/34, 35
ANGLE (DEG)
SPEED (KNOTS)

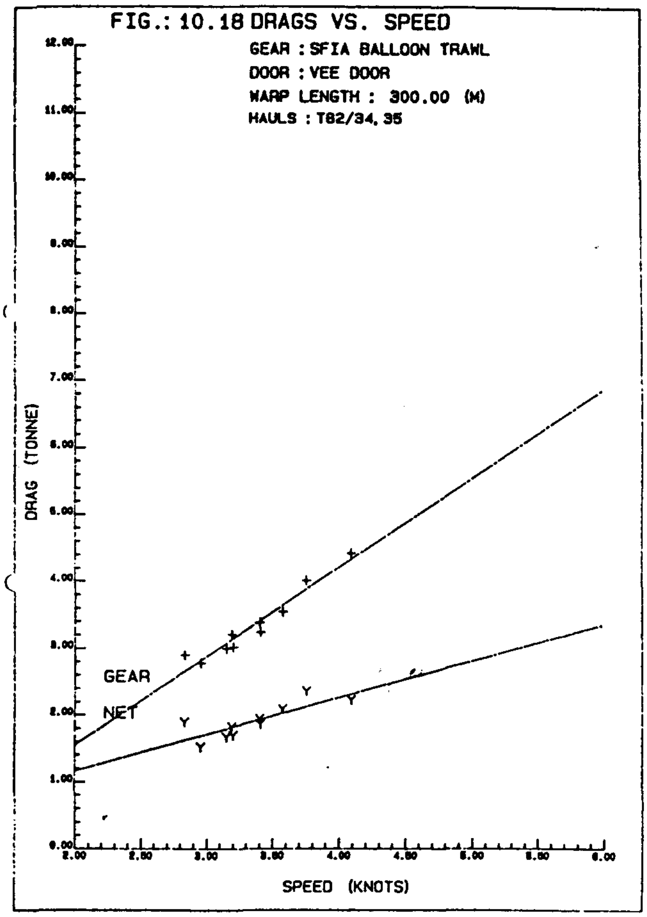


FIG.: 10.18 DRAGS VS. SPEED
GEAR : SFIA BALLOON TRAWL
DOOR : VEE DOOR
WARP LENGTH : 300.00 (M)
HAULS : T82/34, 35
DRAG (TONNE)
GEAR
NET
SPEED (KNOTS)

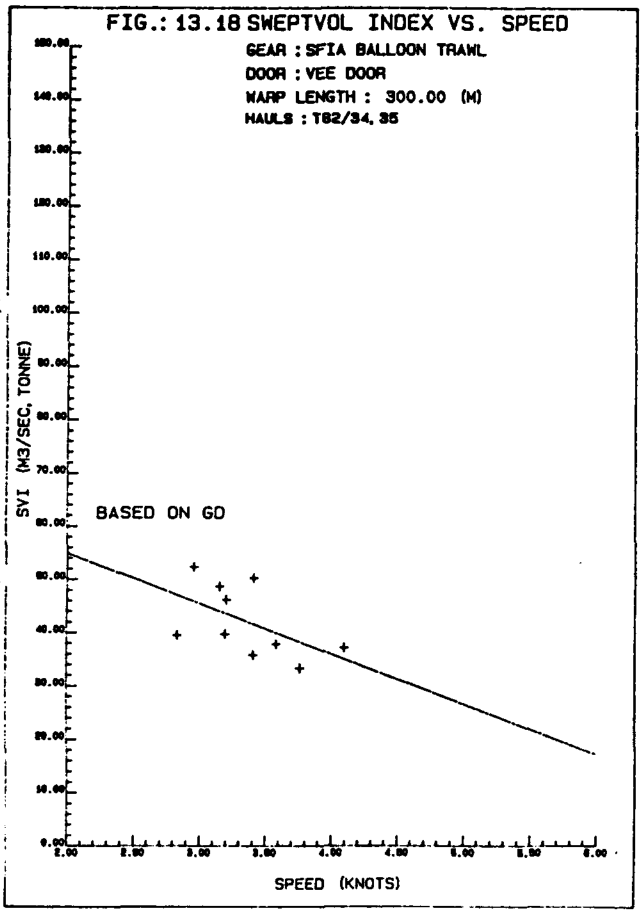


FIG.: 13.18 SWEPTVOL INDEX VS. SPEED
GEAR : SFIA BALLOON TRAWL
DOOR : VEE DOOR
WARP LENGTH : 300.00 (M)
HAULS : T82/34, 35
SVI (M3/SEC, TONNE)
BASED ON GD
SPEED (KNOTS)

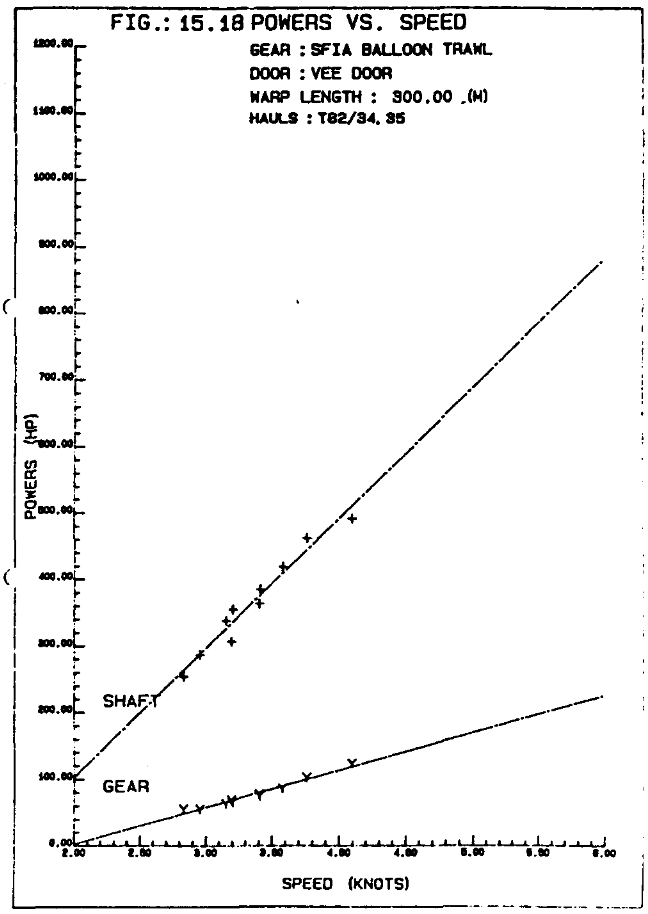


FIG.: 15.18 POWERS VS. SPEED
GEAR : SFIA BALLOON TRAWL
DOOR : VEE DOOR
WARP LENGTH : 300.00 (M)
HAULS : T82/34, 35
POWERS (HP)
SHAFT
GEAR
SPEED (KNOTS)

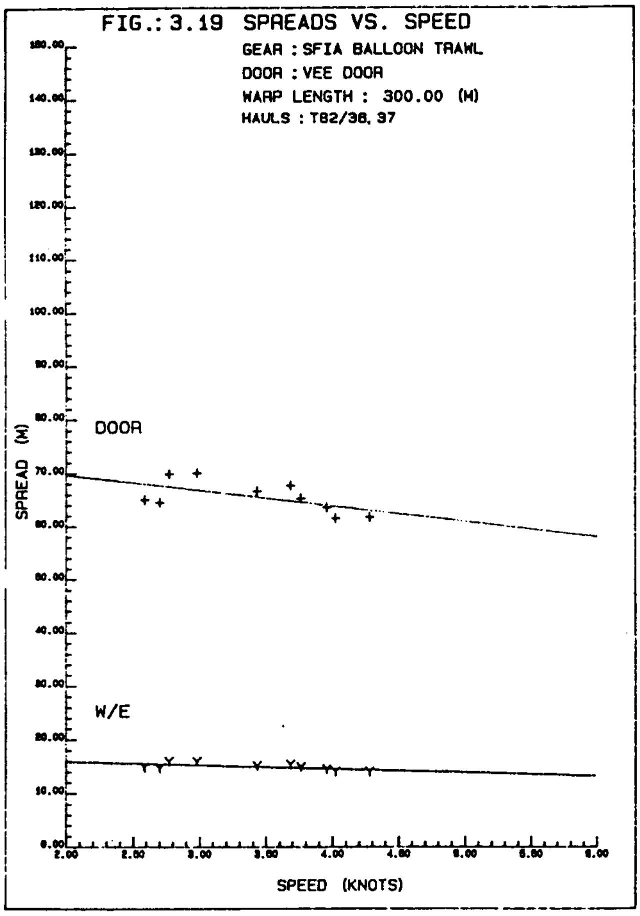


FIG.: 3.19 SPREADS VS. SPEED

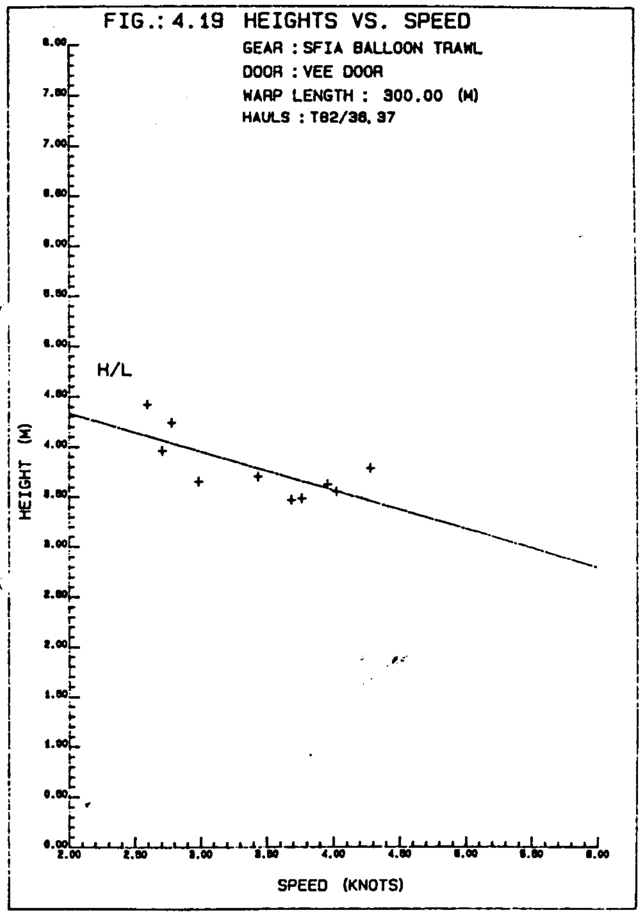


FIG.: 4.19 HEIGHTS VS. SPEED

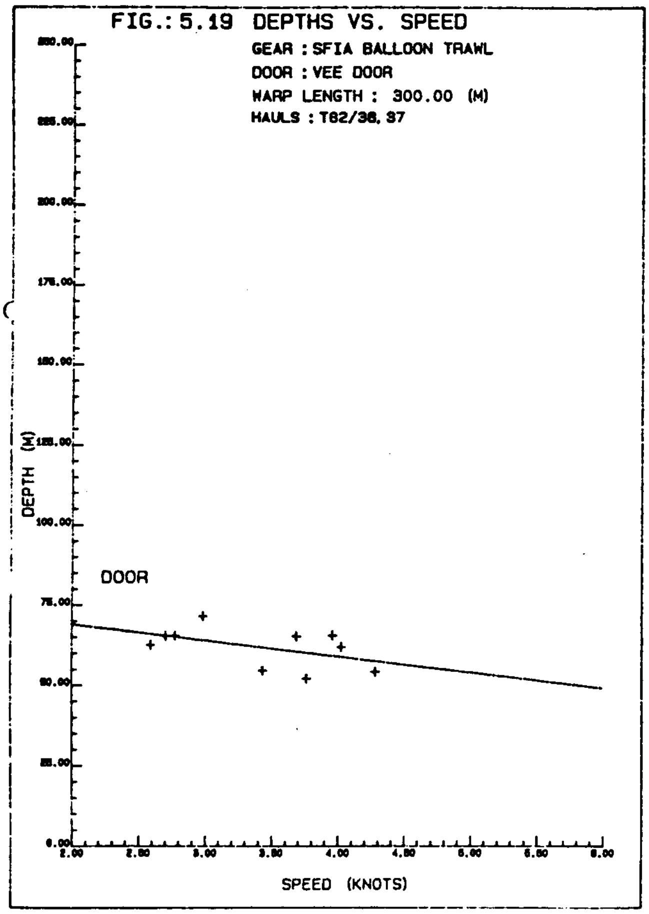


FIG.: 5.19 DEPTHS VS. SPEED

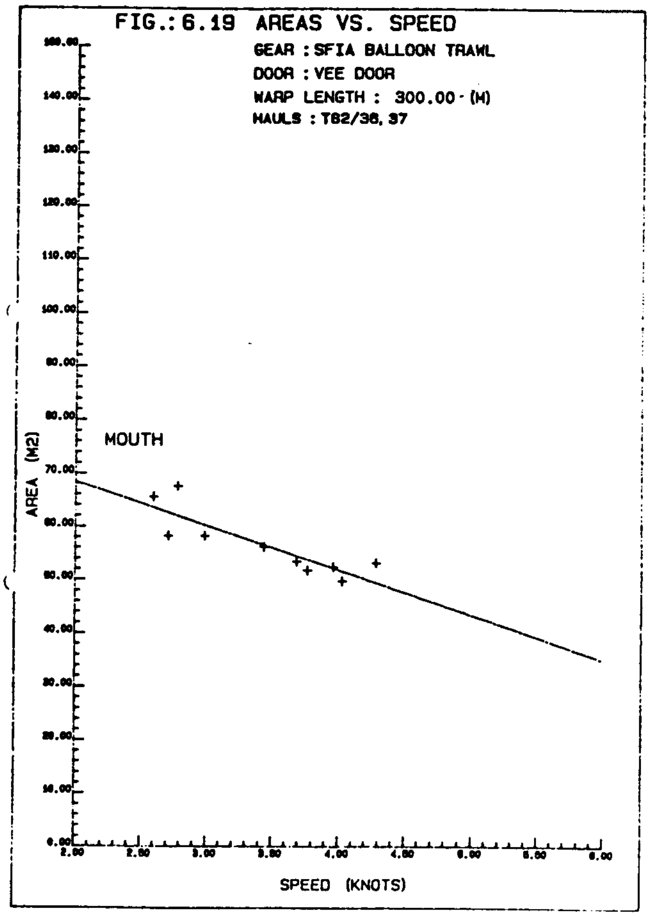


FIG.: 6.19 AREAS VS. SPEED

FIG.: 9.19 SWEEP DIVERGENCE VS. SPEED

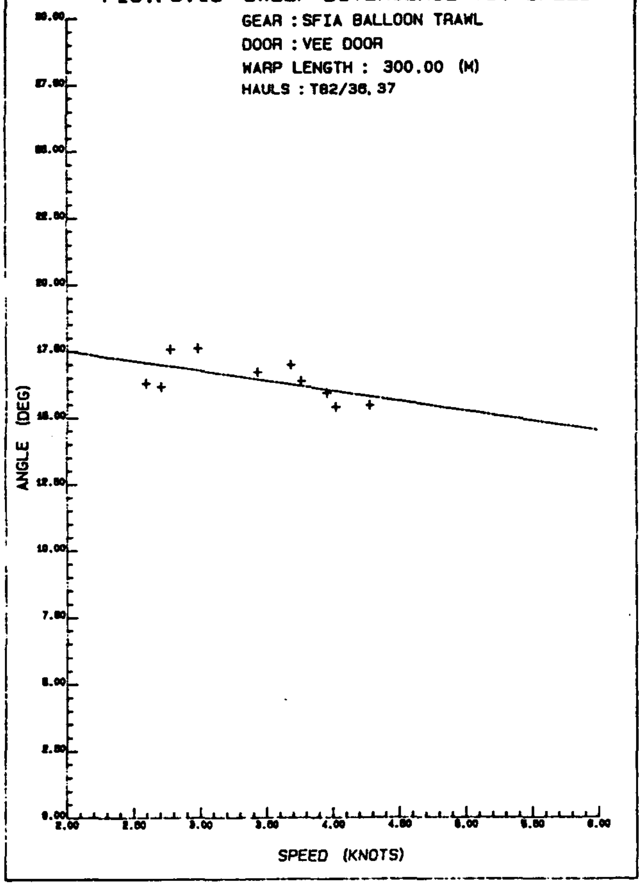


FIG.: 10.19 DRAGS VS. SPEED

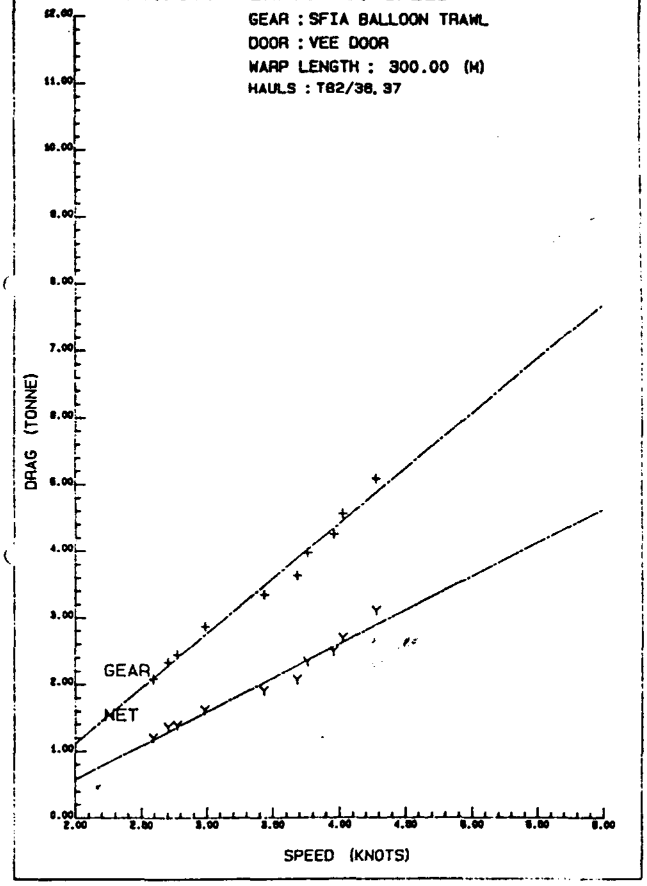


FIG.: 13.19 SWEPTVOL INDEX VS. SPEED

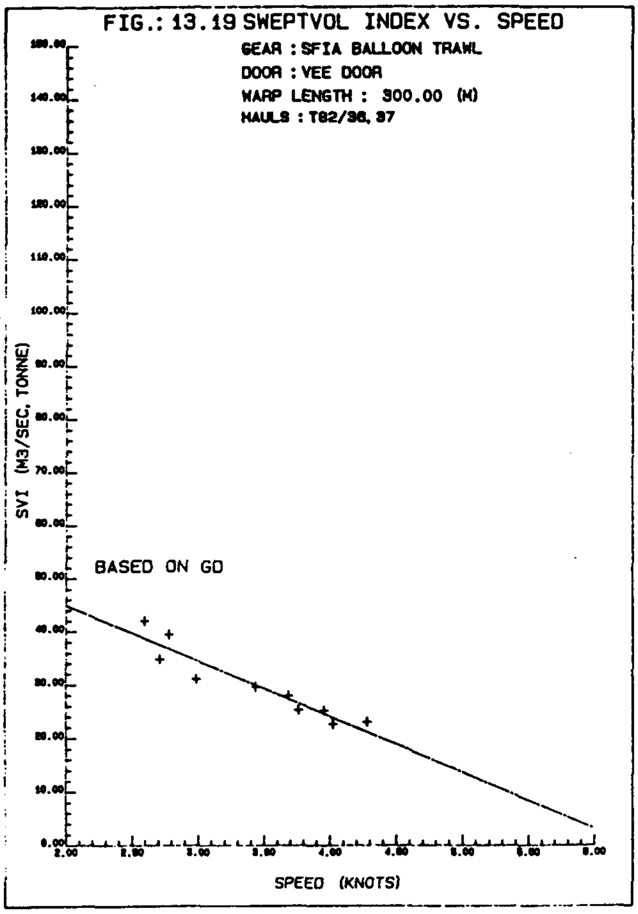
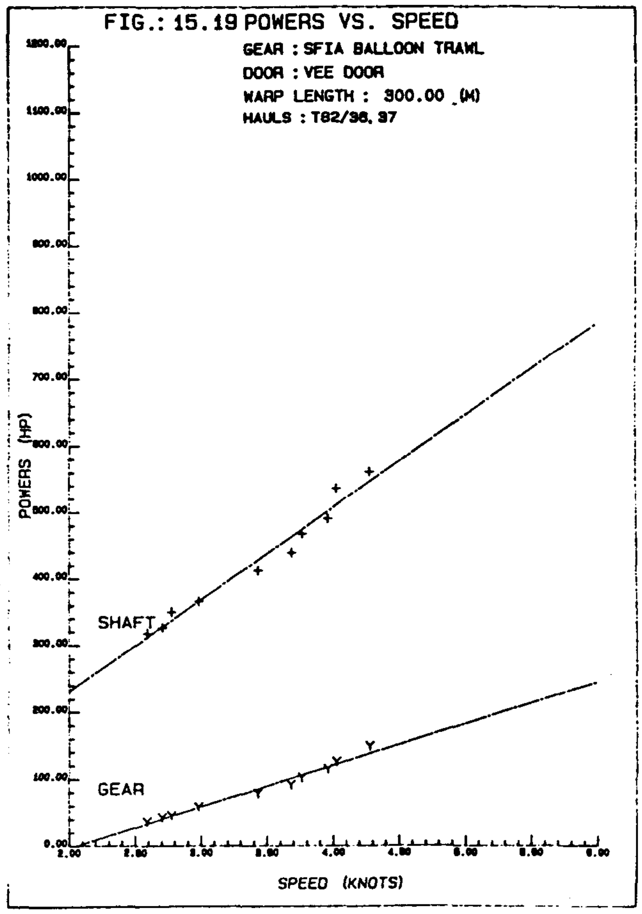


FIG.: 15.19 POWERS VS. SPEED



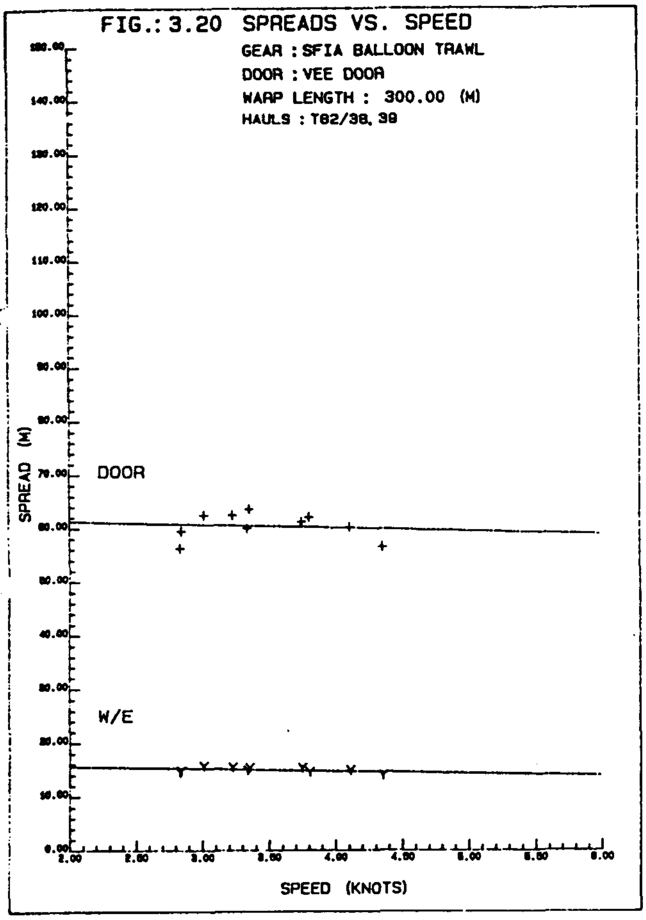


FIG.: 3.20 SPREADS VS. SPEED
GEAR : SFIA BALLOON TRAWL
DOOR : VEE DOOR
WARP LENGTH : 300.00 (M)
HAULS : T82/38, 39
SPREAD (M)
DOOR
W/E
SPEED (KNOTS)

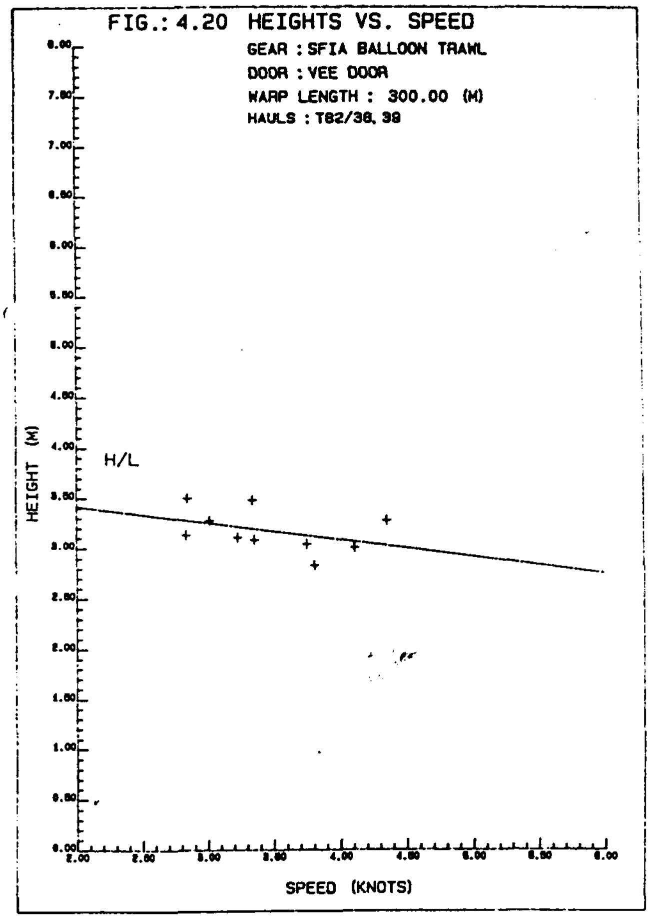


FIG.: 4.20 HEIGHTS VS. SPEED
GEAR : SFIA BALLOON TRAWL
DOOR : VEE DOOR
WARP LENGTH : 300.00 (M)
HAULS : T82/38, 39
HEIGHT (M)
H/L
SPEED (KNOTS)

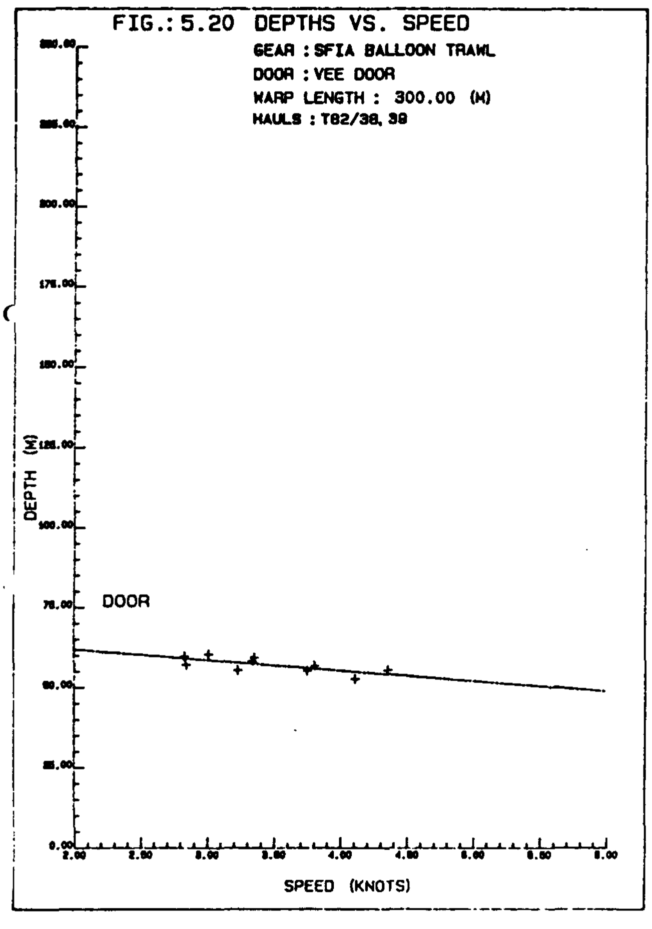


FIG.: 5.20 DEPTHS VS. SPEED
GEAR : SFIA BALLOON TRAWL
DOOR : VEE DOOR
WARP LENGTH : 300.00 (M)
HAULS : T82/38, 39
DEPTH (M)
DOOR
SPEED (KNOTS)

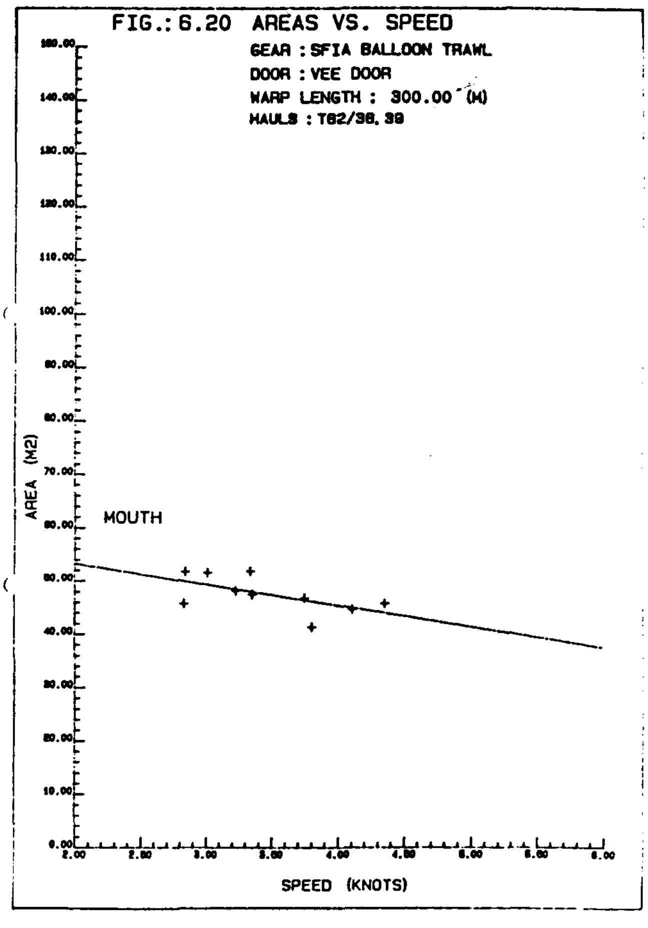


FIG.: 6.20 AREAS VS. SPEED
GEAR : SFIA BALLOON TRAWL
DOOR : VEE DOOR
WARP LENGTH : 300.00 (M)
HAULS : T82/38, 39
AREA (M2)
MOUTH
SPEED (KNOTS)

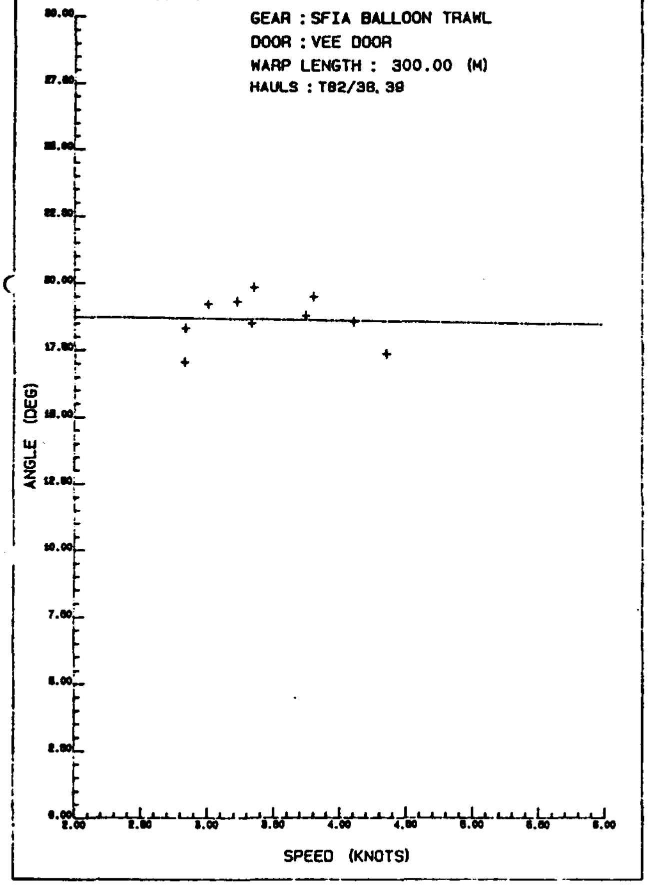


FIG.: 9.20 SWEEP DIVERGENCE VS. SPEED

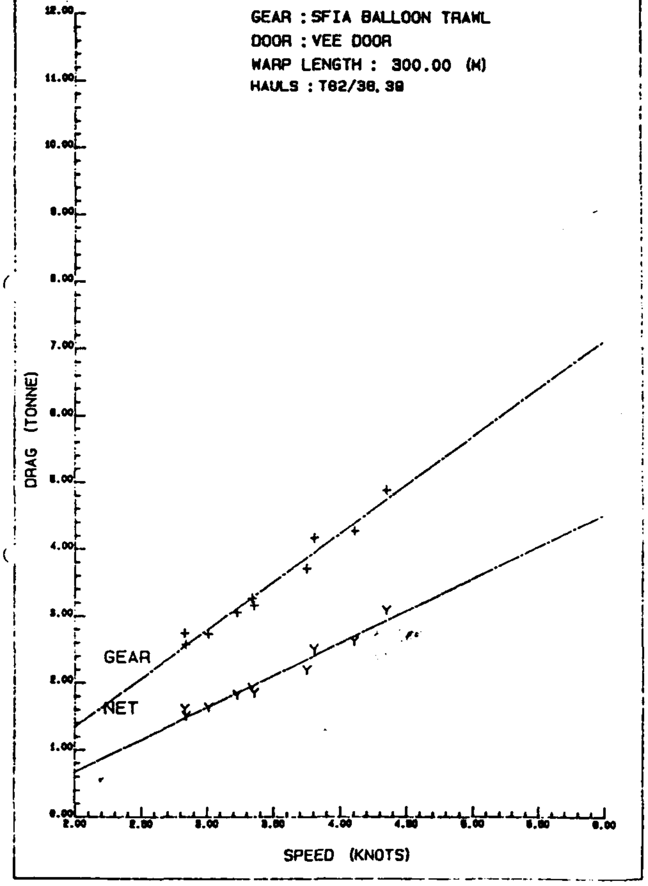


FIG.: 10.20 DRAGS VS. SPEED

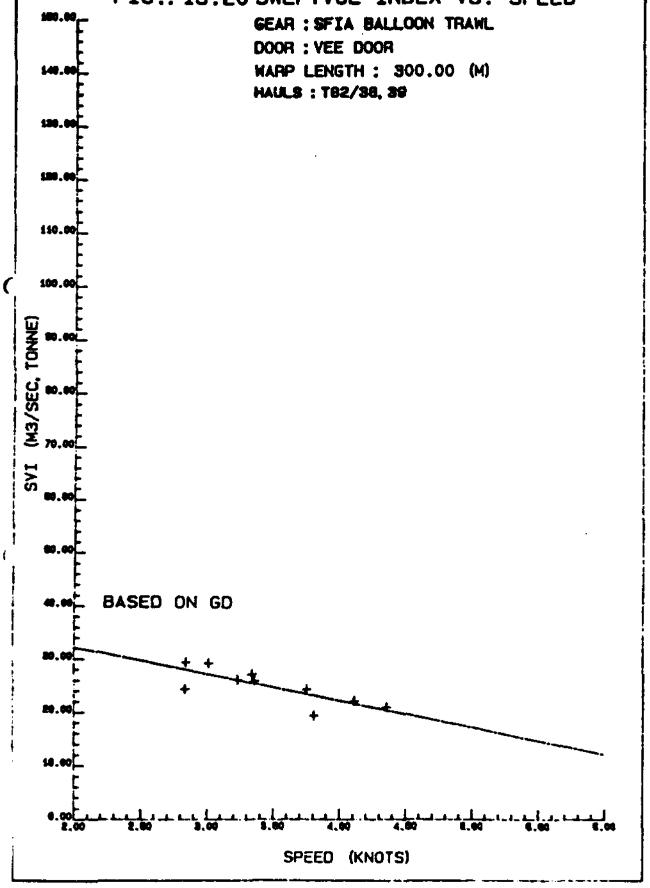


FIG.: 13.20 SWEPTVOL INDEX VS. SPEED

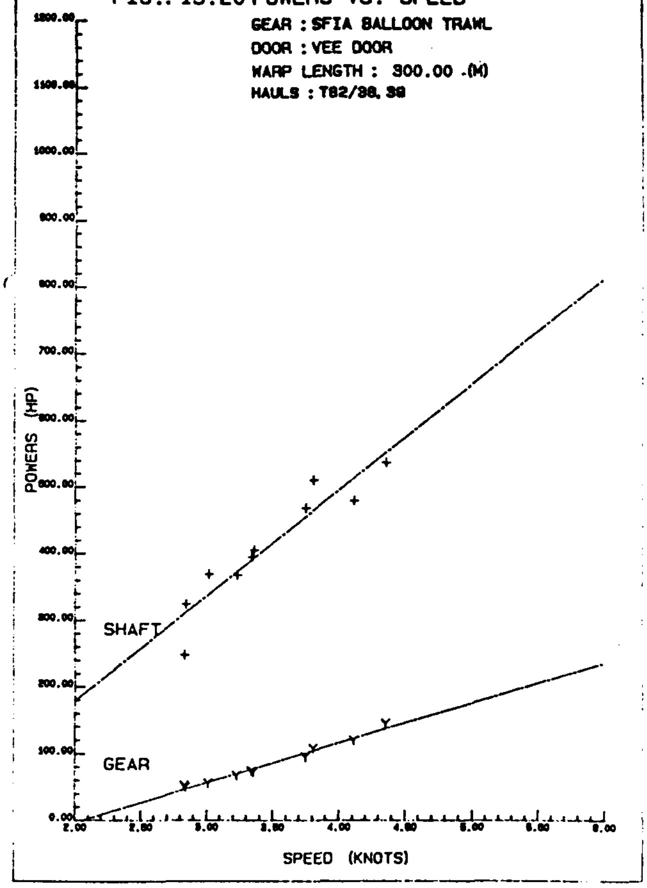


FIG.: 15.20 POWERS VS. SPEED

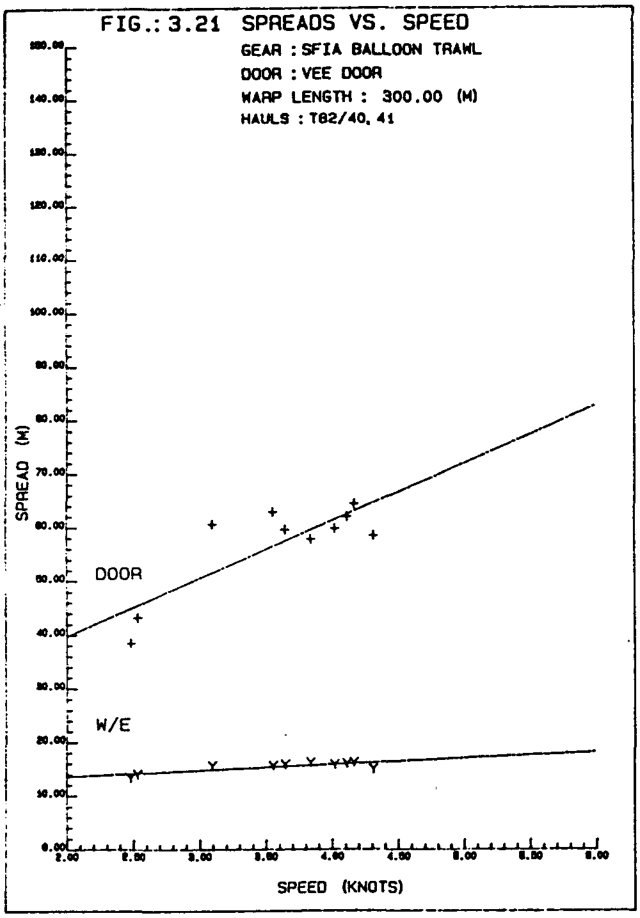


FIG.: 3.21 SPREADS VS. SPEED

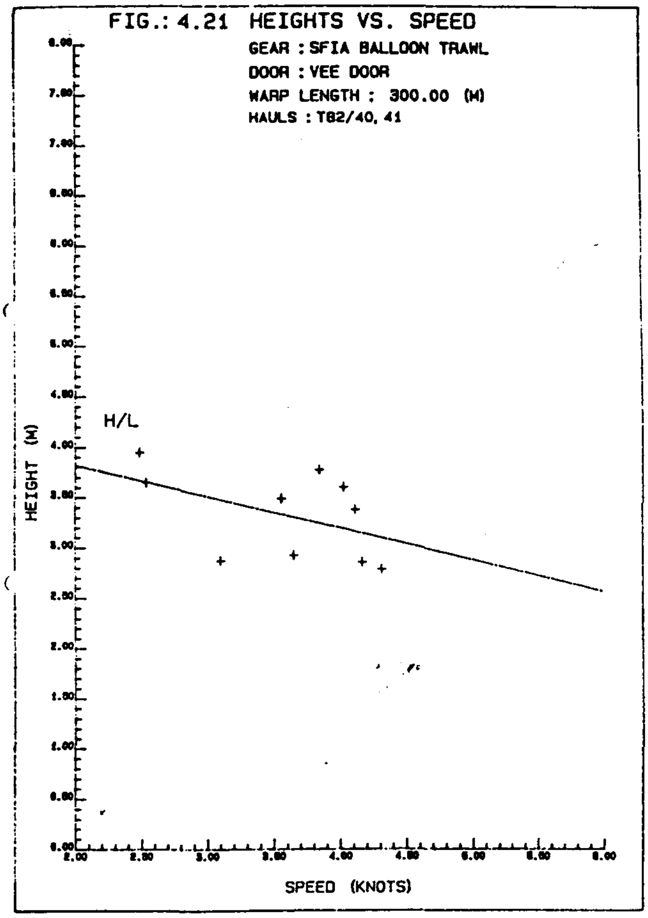


FIG.: 4.21 HEIGHTS VS. SPEED

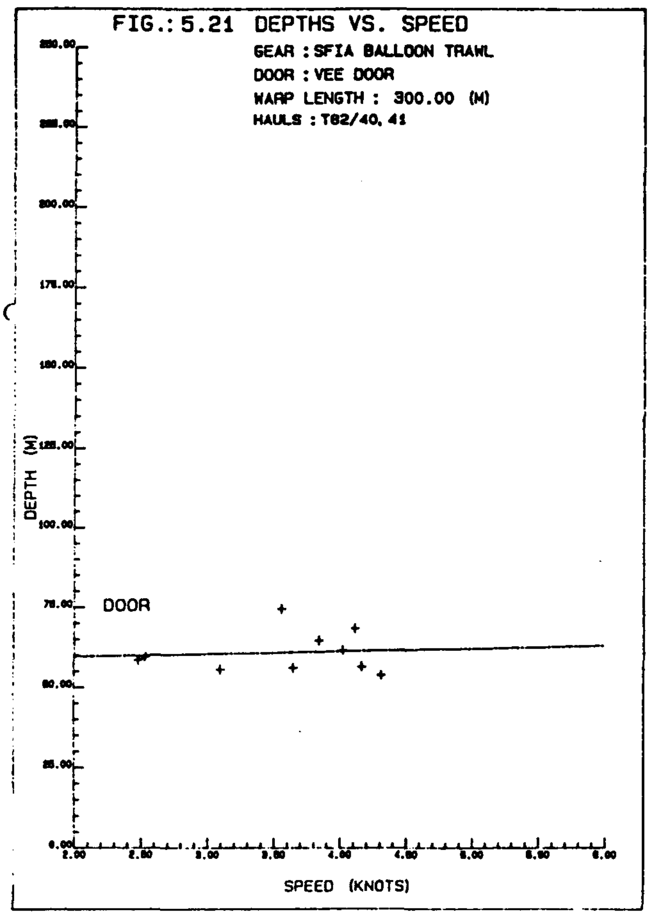


FIG.: 5.21 DEPTHS VS. SPEED

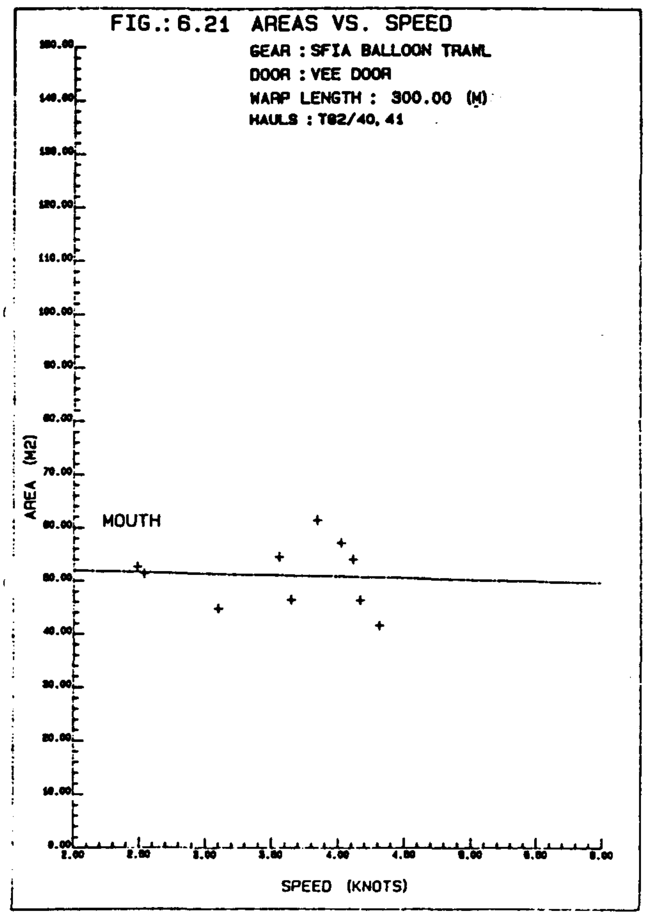


FIG.: 6.21 AREAS VS. SPEED

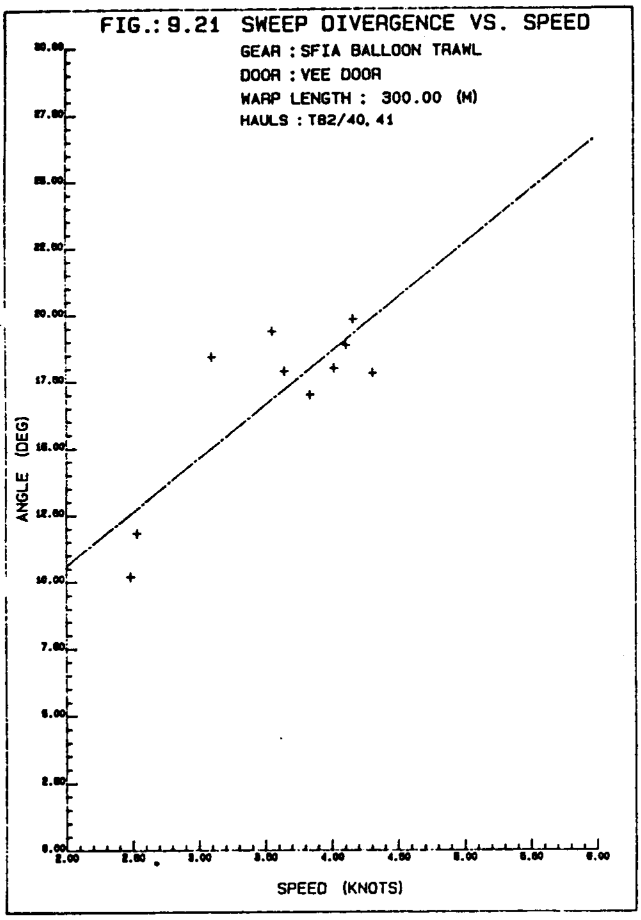


FIG.: 9.21 SWEEP DIVERGENCE VS. SPEED
GEAR : SFIA BALLOON TRAWL
DOOR : VEE DOOR
WARP LENGTH : 300.00 (M)
HAULS : T82/40, 41
ANGLE (DEG)
SPEED (KNOTS)

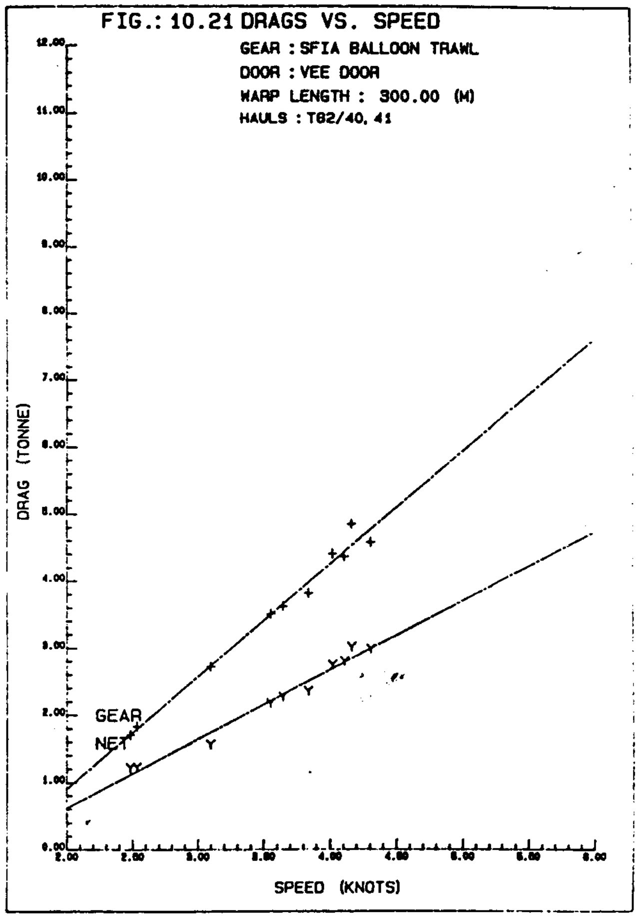


FIG.: 10.21 DRAGS VS. SPEED
GEAR : SFIA BALLOON TRAWL
DOOR : VEE DOOR
WARP LENGTH : 300.00 (M)
HAULS : T82/40, 41
DRAG (TONNE)
GEAR
NET
SPEED (KNOTS)

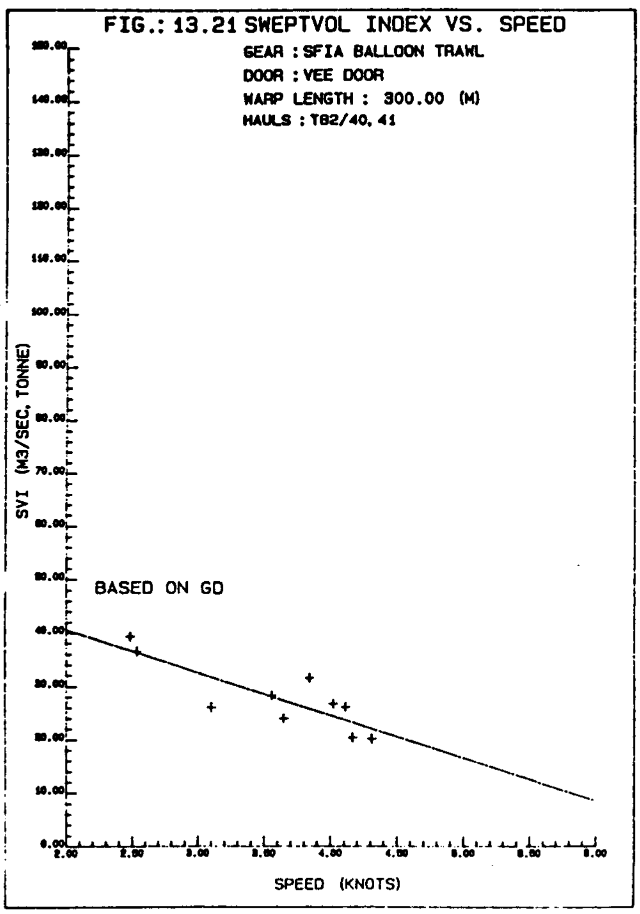


FIG.: 13.21 SWEPTVOL INDEX VS. SPEED
GEAR : SFIA BALLOON TRAWL
DOOR : VEE DOOR
WARP LENGTH : 300.00 (M)
HAULS : T82/40, 41
SVI (M3/SEC, TONNE)
BASED ON GD
SPEED (KNOTS)

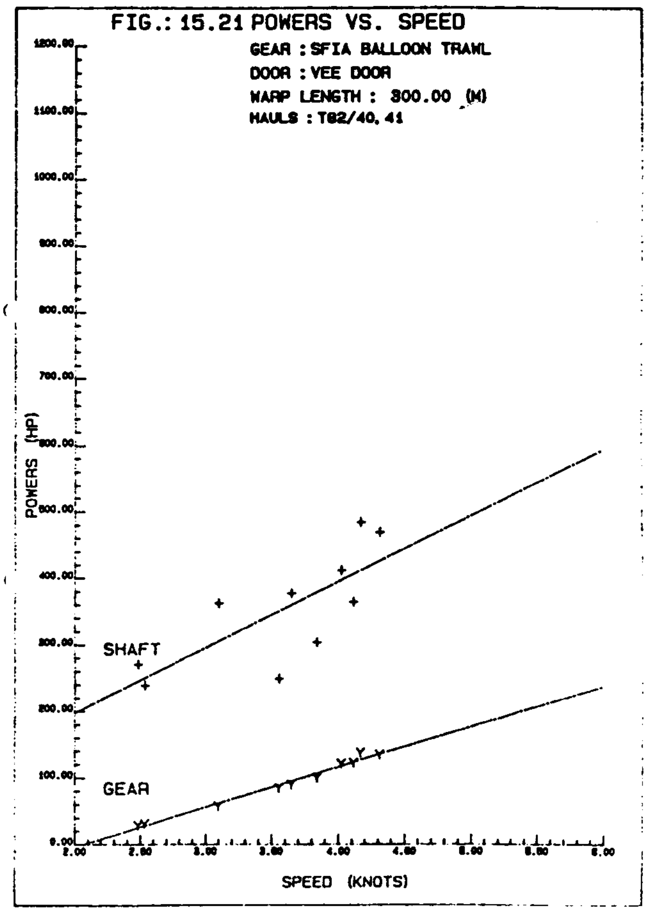


FIG.: 15.21 POWERS VS. SPEED
GEAR : SFIA BALLOON TRAWL
DOOR : VEE DOOR
WARP LENGTH : 300.00 (M)
HAULS : T82/40, 41
POWERS (HP)
SHAFT
GEAR
SPEED (KNOTS)

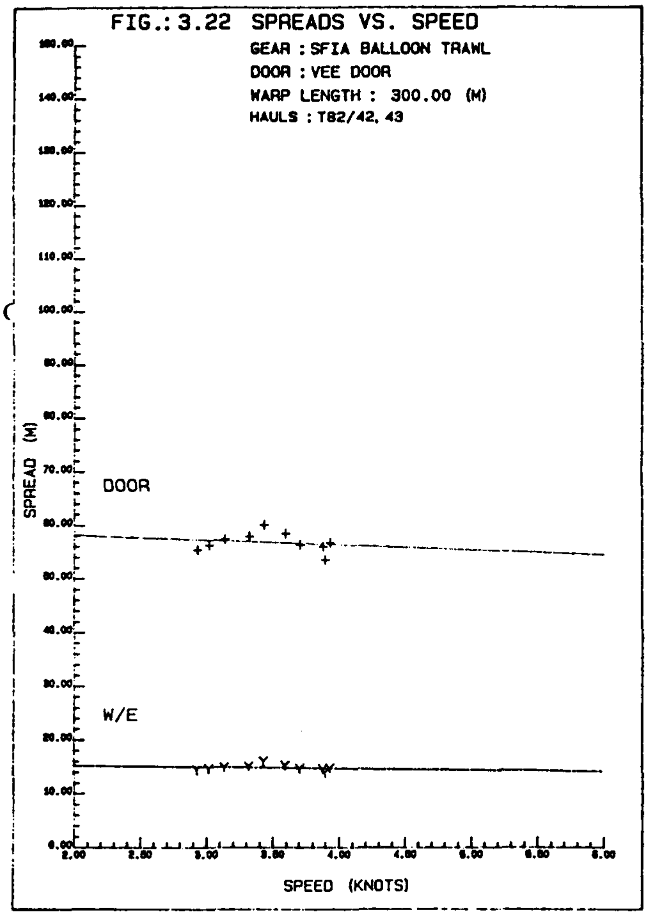


FIG.: 3.22 SPREADS VS. SPEED

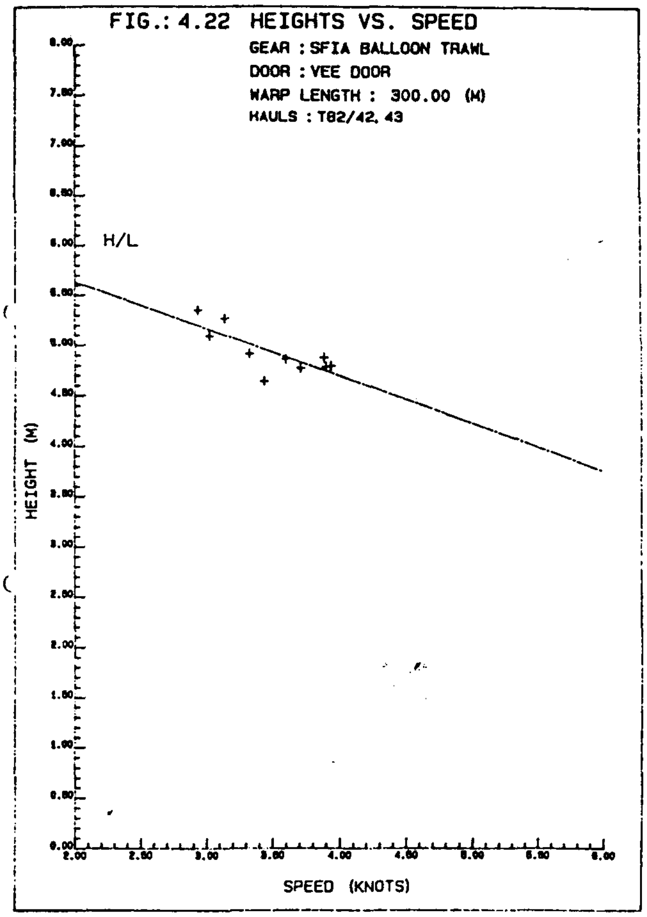


FIG.: 4.22 HEIGHTS VS. SPEED

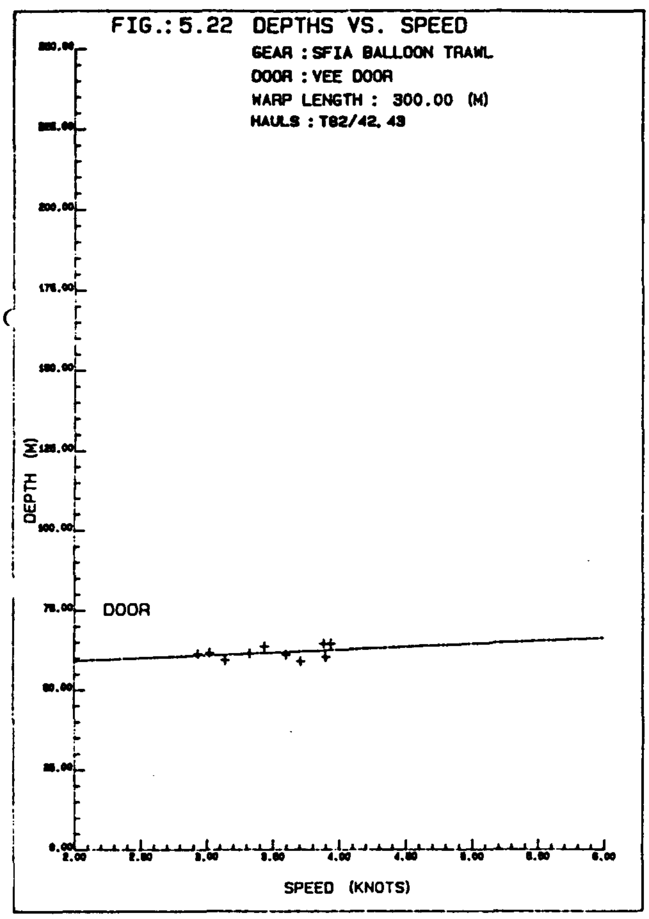


FIG.: 5.22 DEPTHS VS. SPEED

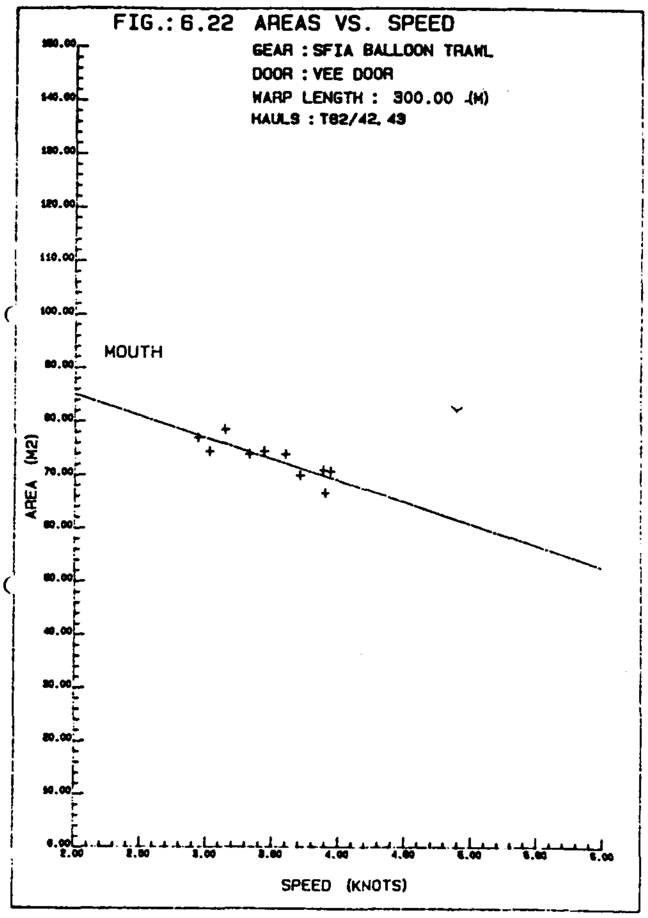


FIG.: 6.22 AREAS VS. SPEED

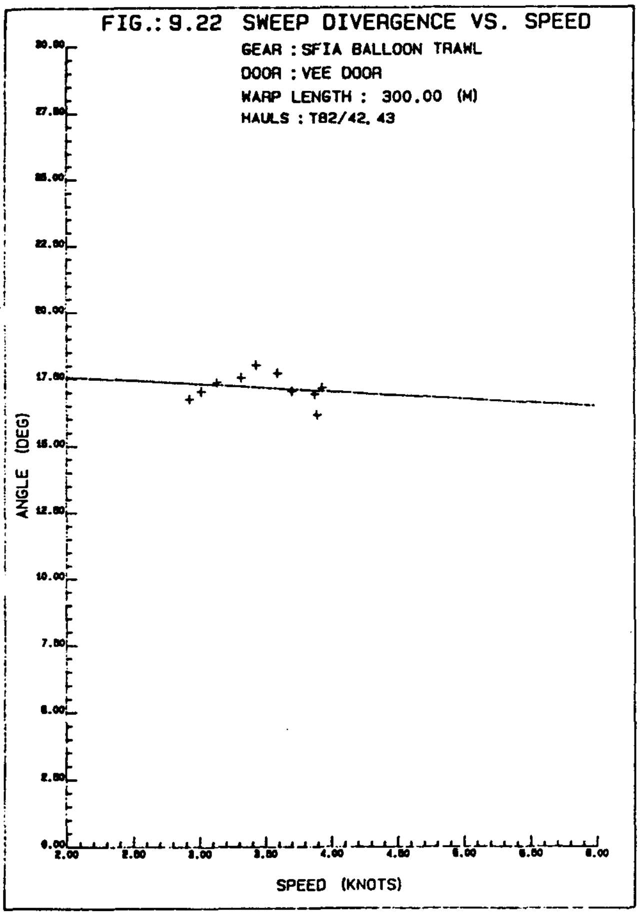


FIG.: 9.22 SWEEP DIVERGENCE VS. SPEED

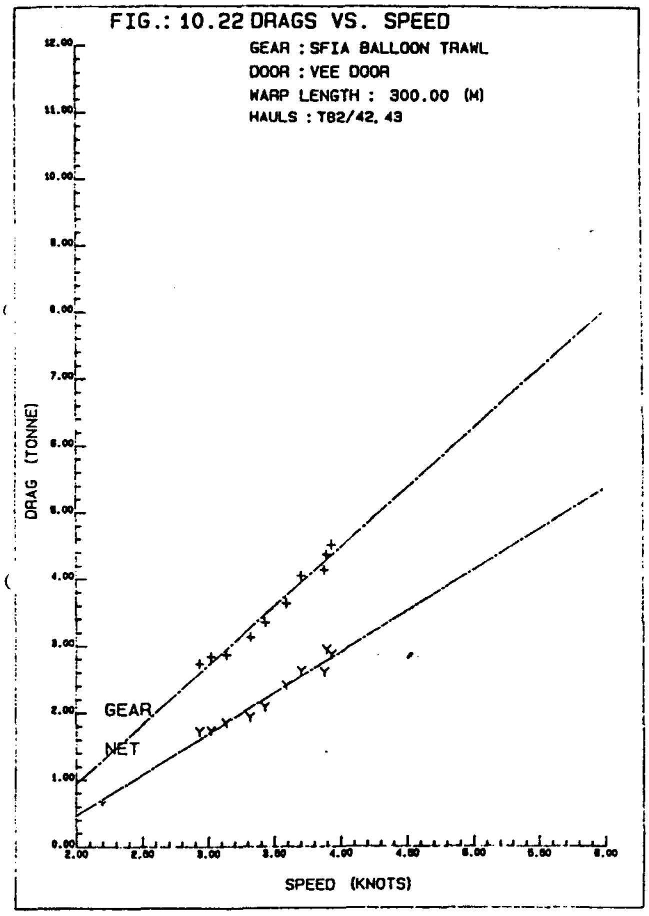


FIG.: 10.22 DRAGS VS. SPEED

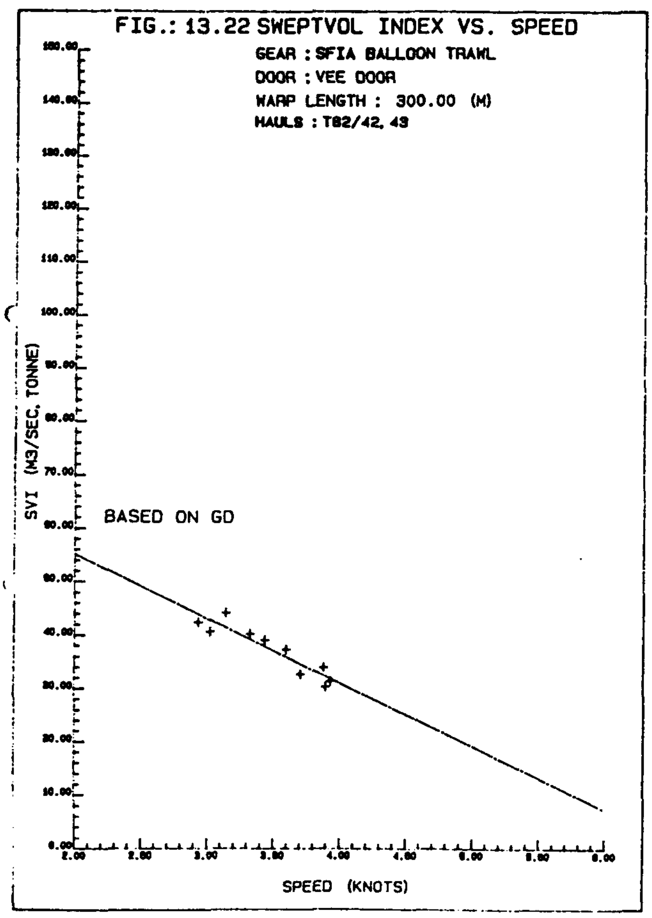


FIG.: 13.22 SWEPTVOL INDEX VS. SPEED

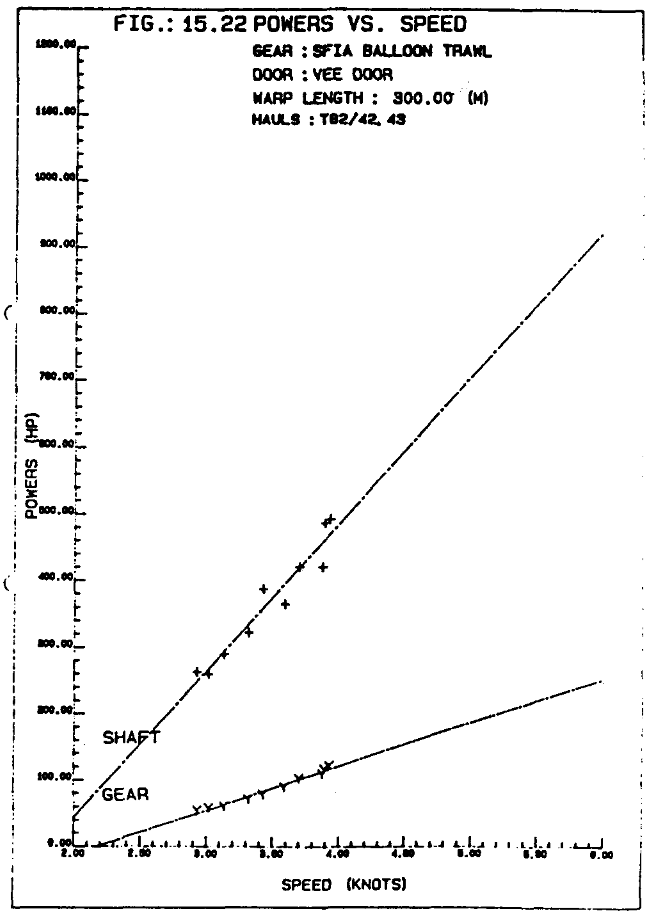


FIG.: 15.22 POWERS VS. SPEED

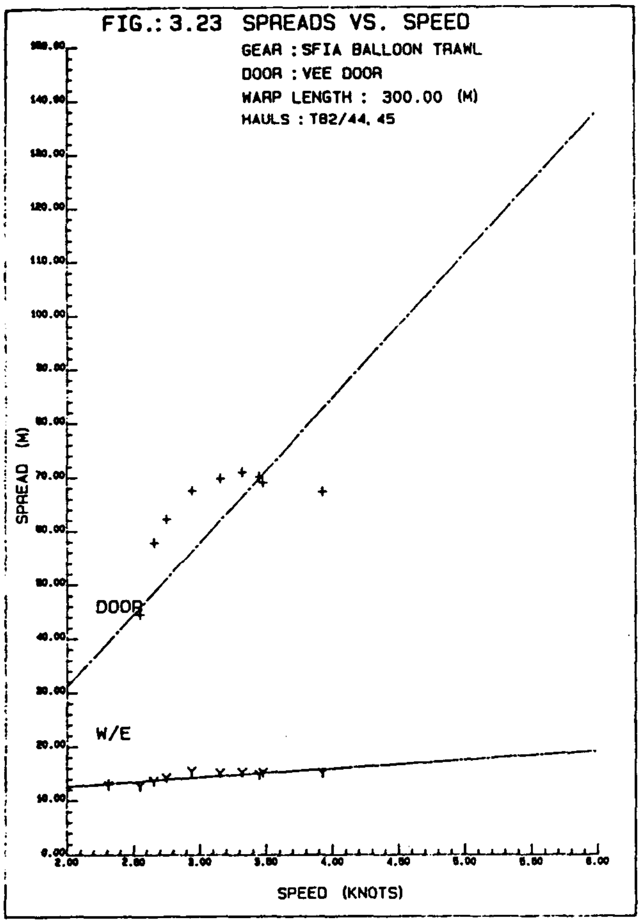


FIG.: 3.23 SPREADS VS. SPEED

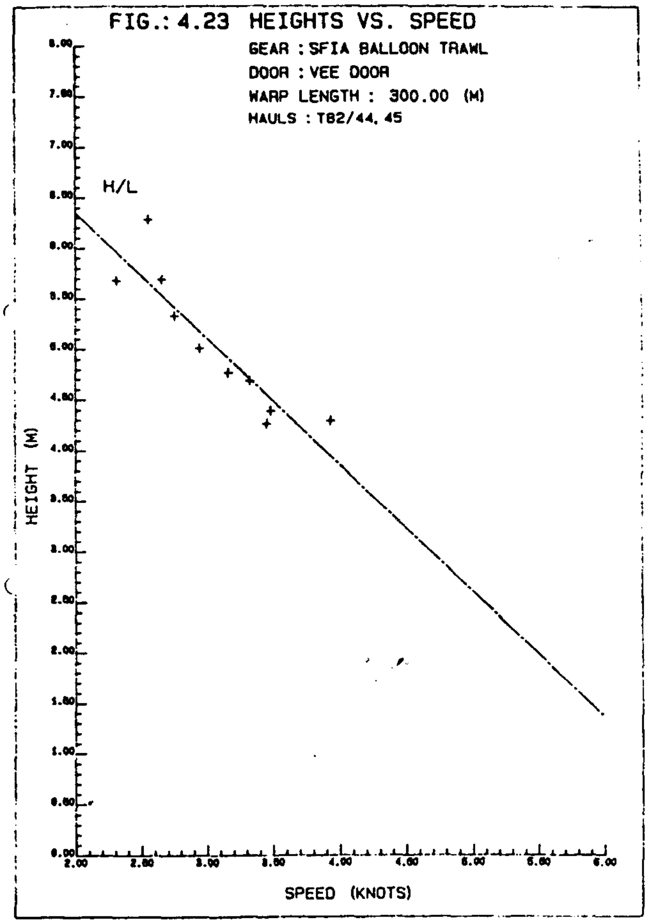


FIG.: 4.23 HEIGHTS VS. SPEED

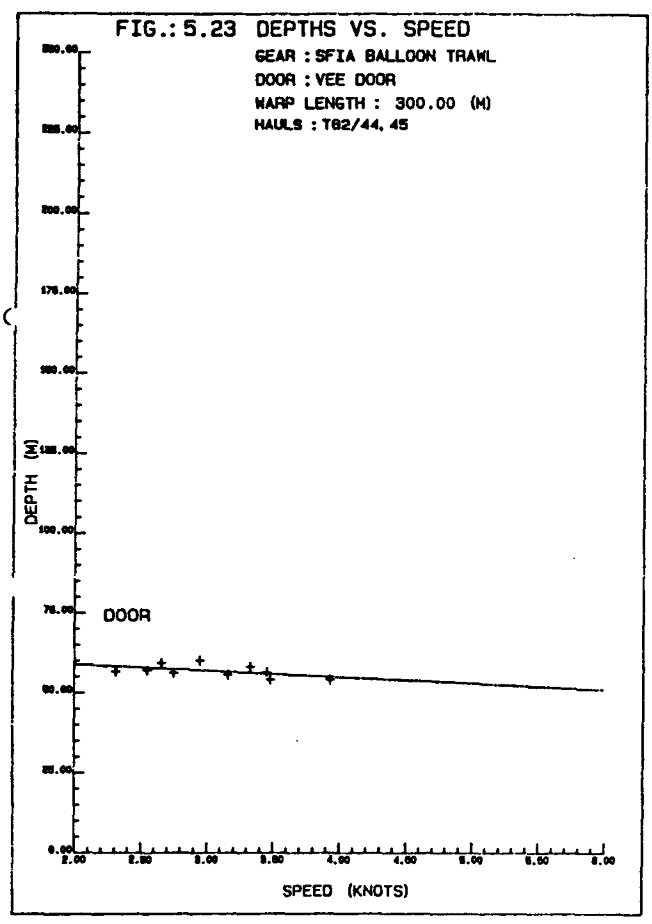


FIG.: 5.23 DEPTHS VS. SPEED

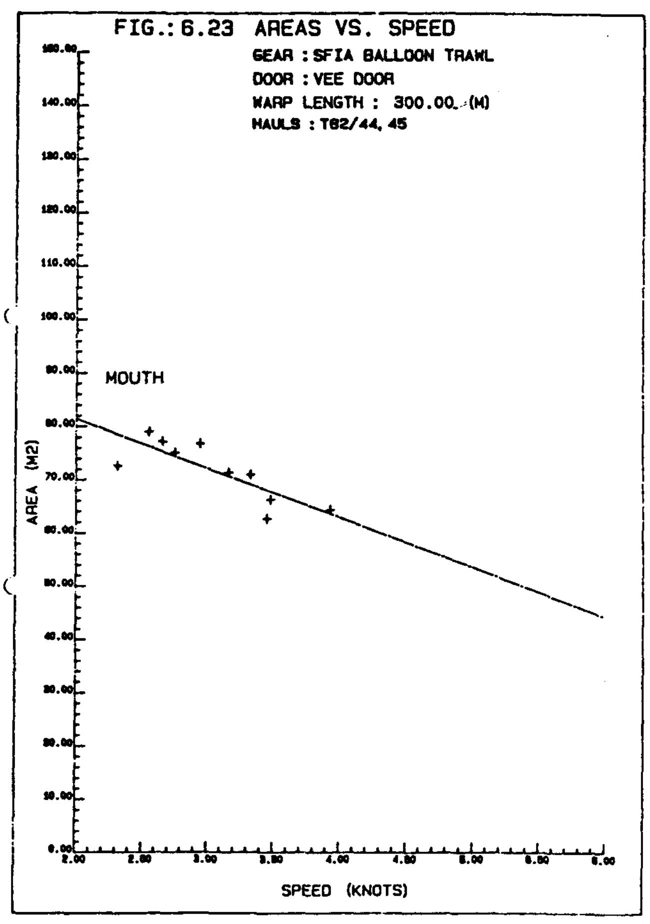


FIG.: 6.23 AREAS VS. SPEED

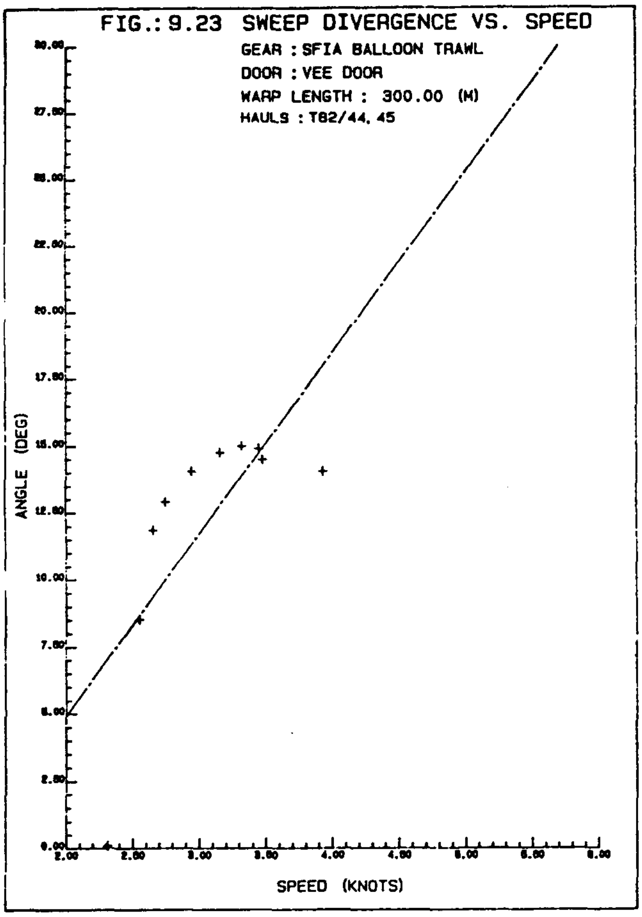


FIG.: 9.23 SWEEP DIVERGENCE VS. SPEED

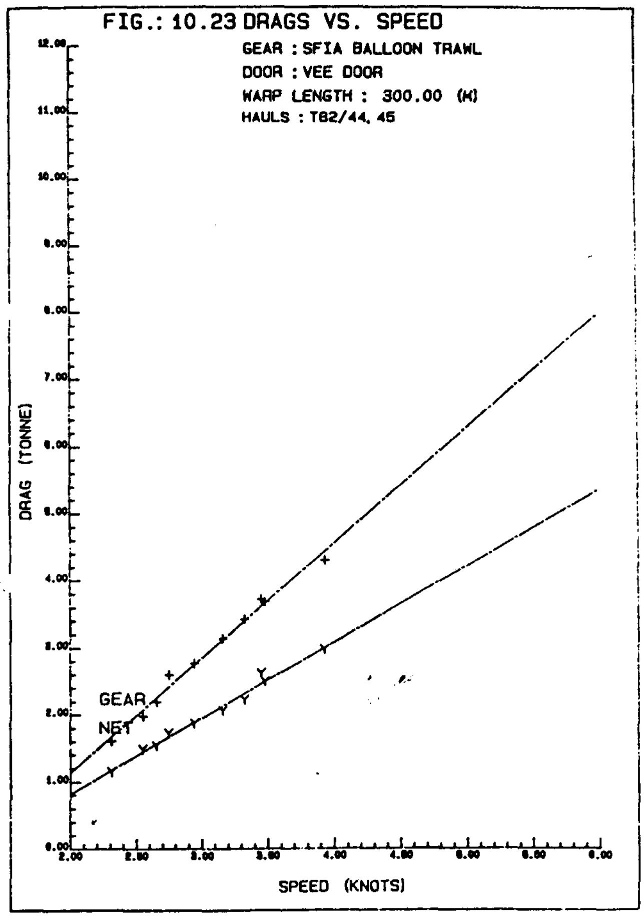


FIG.: 10.23 DRAGS VS. SPEED

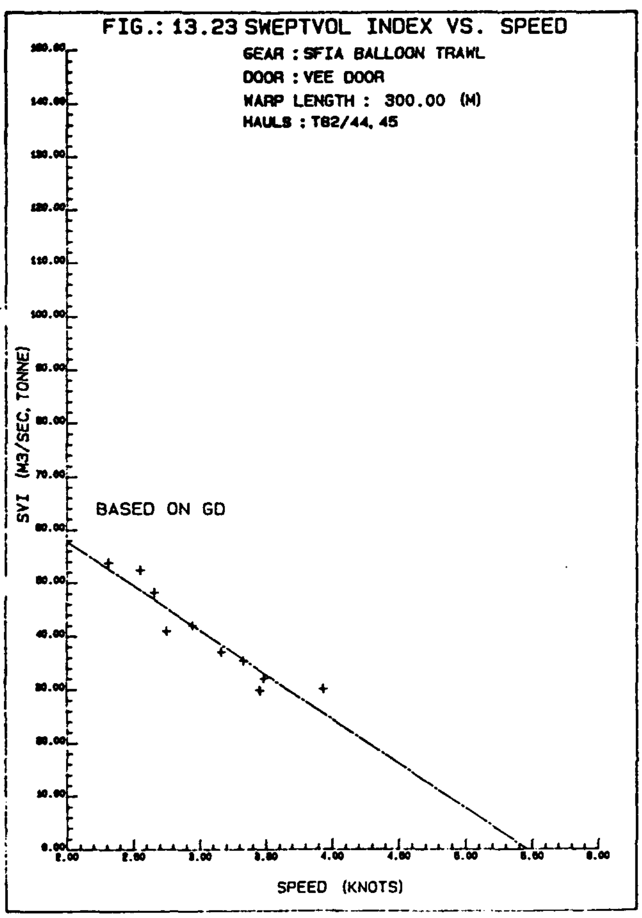


FIG.: 13.23 SWEPTVOL INDEX VS. SPEED

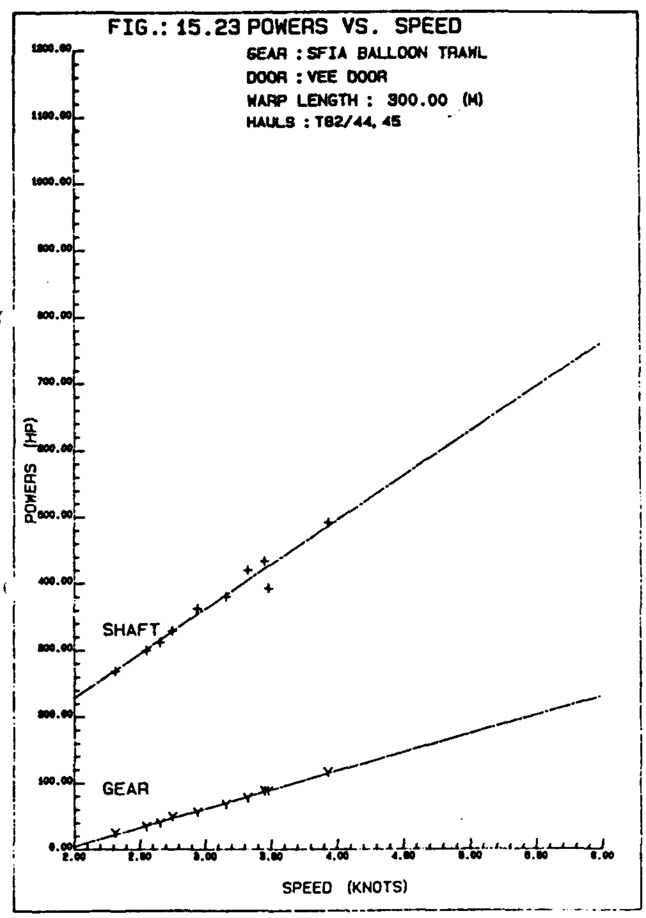


FIG.: 15.23 POWERS VS. SPEED

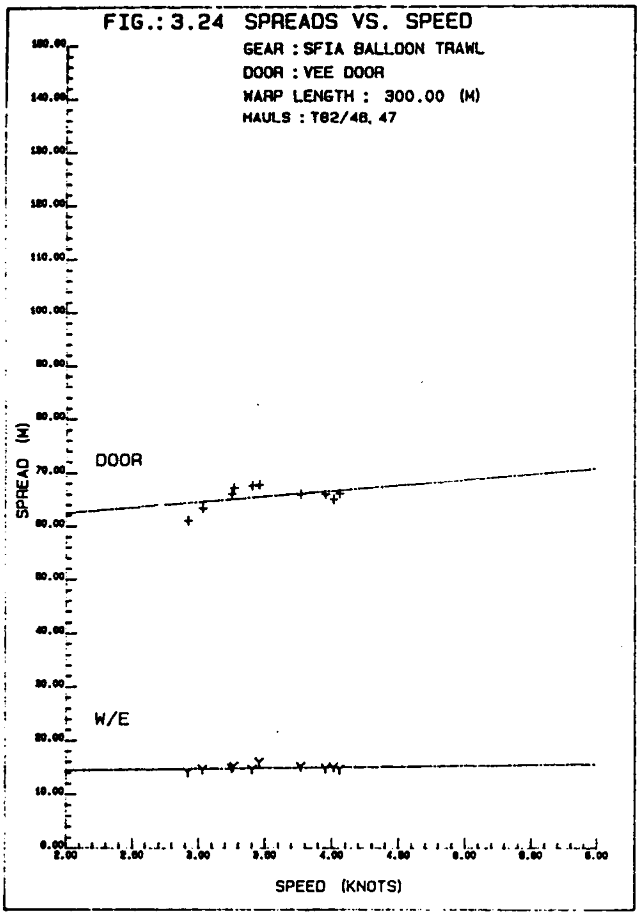


FIG.: 3.24 SPREADS VS. SPEED

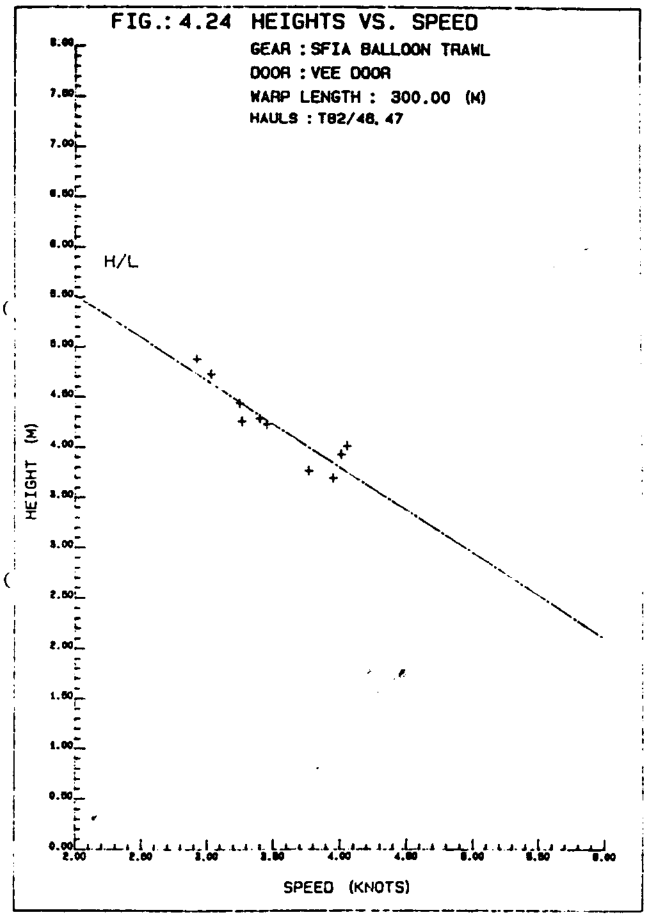


FIG.: 4.24 HEIGHTS VS. SPEED

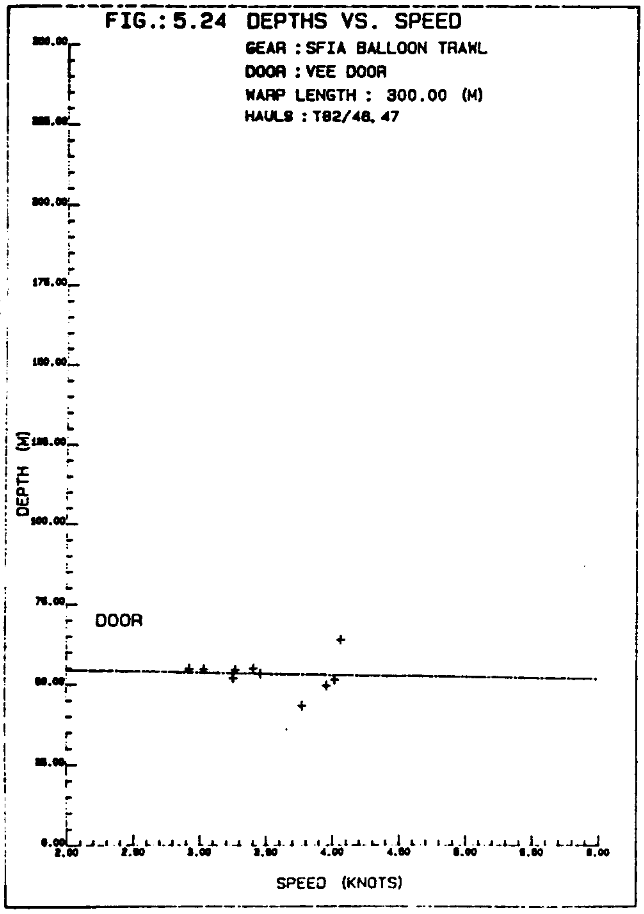


FIG.: 5.24 DEPTHS VS. SPEED

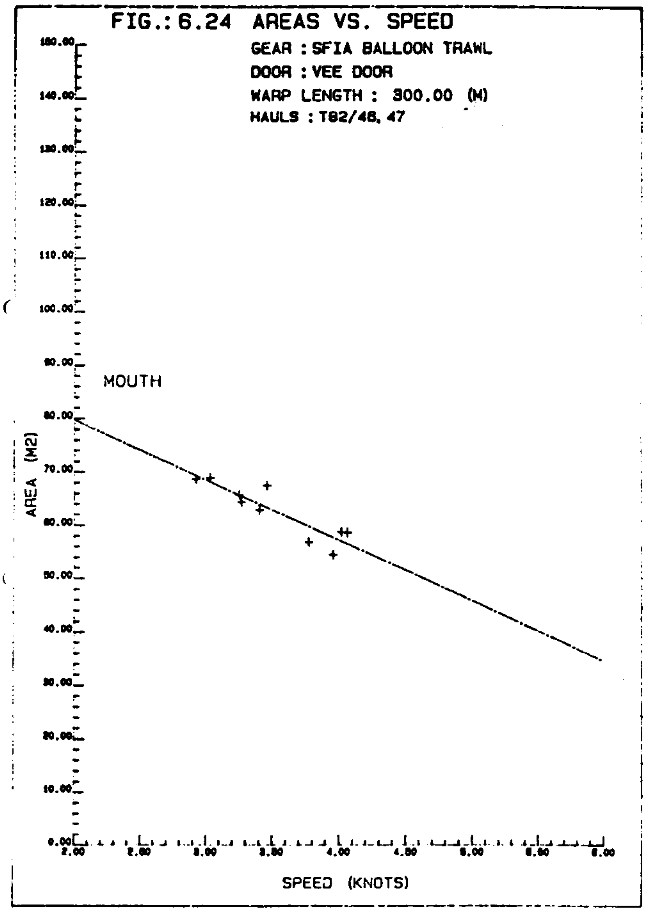


FIG.: 6.24 AREAS VS. SPEED

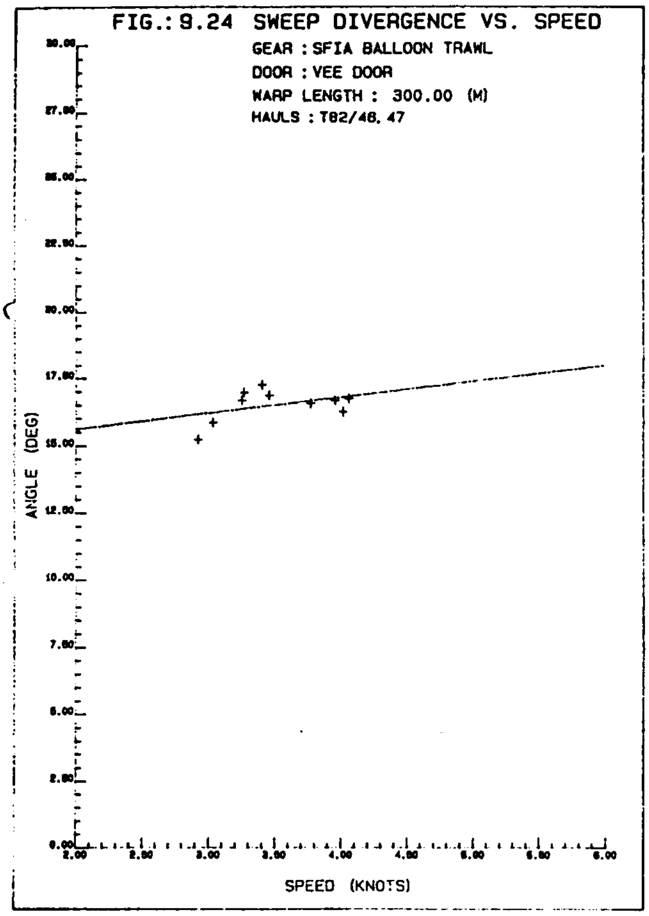


FIG.: 9.24 SWEEP DIVERGENCE VS. SPEED
GEAR : SFIA BALLOON TRAWL
DOOR : VEE DOOR
WARP LENGTH : 300.00 (M)
HAULS : T82/46, 47
ANGLE (DEG)
SPEED (KNOTS)

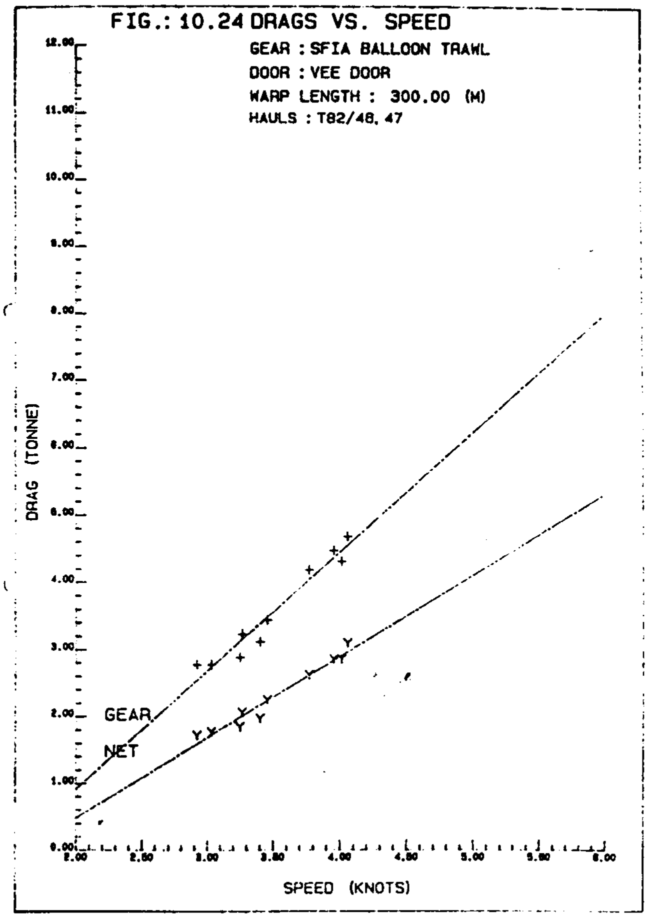


FIG.: 10.24 DRAGS VS. SPEED
GEAR : SFIA BALLOON TRAWL
DOOR : VEE DOOR
WARP LENGTH : 300.00 (M)
HAULS : T82/46, 47
DRAG (TONNE)
GEAR
NET
SPEED (KNOTS)

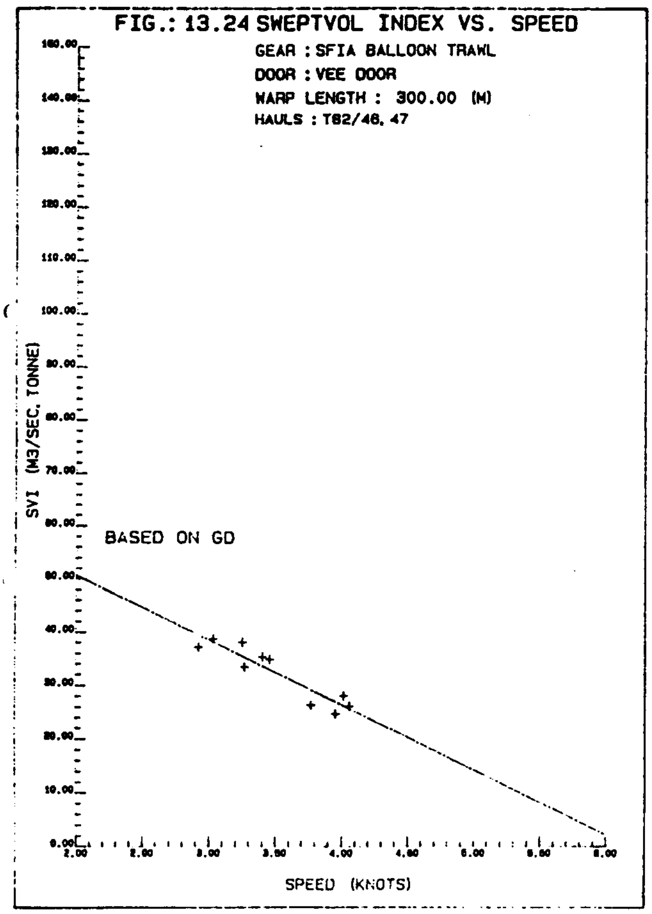


FIG.: 13.24 SWEPTVOL INDEX VS. SPEED
GEAR : SFIA BALLOON TRAWL
DOOR : VEE DOOR
WARP LENGTH : 300.00 (M)
HAULS : T82/46, 47
SVI (M3/SEC, TONNE)
BASED ON GD
SPEED (KNOTS)

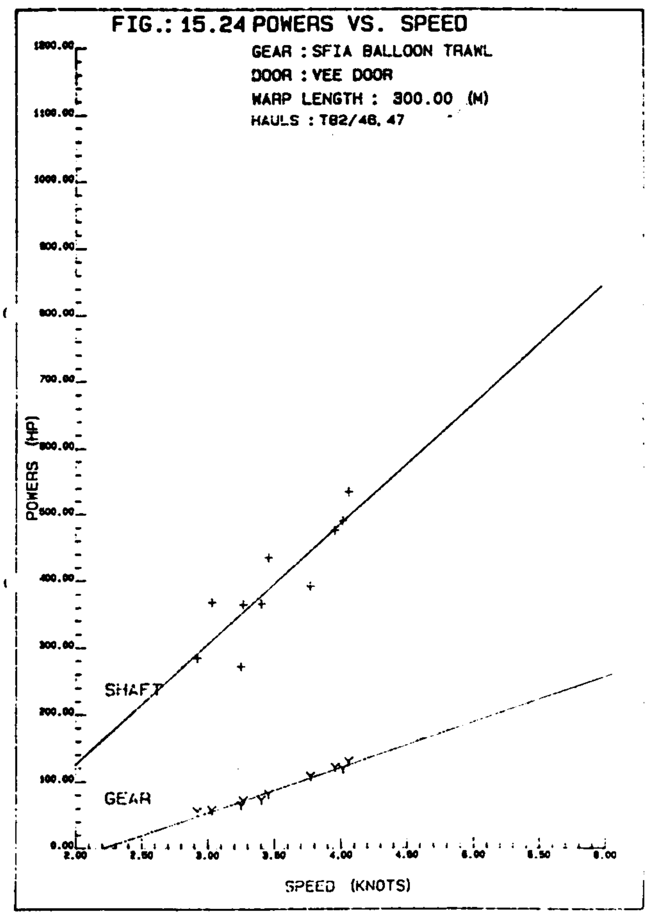


FIG.: 15.24 POWERS VS. SPEED
GEAR : SFIA BALLOON TRAWL
DOOR : VEE DOOR
WARP LENGTH : 300.00 (M)
HAULS : T82/46, 47
POWERS (HP)
SHAFT
GEAR
SPEED (KNOTS)