# Wave Statistics for the North Atlantic 1970 to 1982

R.E. Walker

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Atlantic Oceanographic Laboratory Ocean Science and Surveys, Atlantic Department of Fisheries and Oceans

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January 1984

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Canadian Data Report of Hydrography and Ocean Sciences No. 16



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# Rapport statistique canadien sur l'hydrographie et les sciences océaniques

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Les établissements des Sciences et Levés océaniques dans les régions et à l'administration centrale ont cessé de publier leurs diverses séries de rapports depuis décembre 1981. Vous trouverez dans l'index des publications du volume 38 du Journal canadien des sciences halieutiques et aquatiques, la liste de ces publications ainsi que le dernier numéro paru dans chaque catégorie. La nouvelle série a commencé avec la publication du Rapport nº 1 en janvier 1982.

# Canadian Data Report of Hydrography and Ocean Sciences No. 16

January 1984

WAVE STATISTICS FOR THE NORTH ATLANTIC - 1970 TO 1982

by

R.E. Walker

Atlantic Oceanographic Laboratory Ocean Science and Surveys, Atlantic Department of Fisheries and Oceans

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#### ABSTRACT

Walker, R.E. 1984. Wave Statistics for the North Atlantic - 1970 to 1982. Can. Data Rep. Hydrogr. Ocean Sci. 16; iv + 291 p.

Monthly wave height distributions of a 13 year (1970-1982) time series of wave data charts issued every 12 hours for the North Atlantic are presented. Also included are the combined 13 year wave height distributions.

The graphs presented have been expanded to permit extrapolation of the distribution to the 100 year probability value.

## RESUME

Walker, R.E. 1984. Wave Statistics for the North Atlantic ~ 1970 to 1982. Can. Data Rep. Hydrogr. Ocean Sci. 16: iv + 291 p.

On présente les répartitions mensuelles de la hauteur des vagues pendant une période de 13 ans (1970-1982 à partir de cartes émises chaque 12 heures) des données sur les vagues dans l'Atlantique-Nord. L'étude fournit également les répartitions combinées de la hauteur des vagues pour les 13 années.

On présente des courbes qui ont été prolongées afin de permettre l'extrapolation de la répartition jusqu'à la valeur probable pour 100 ans.

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## INTRODUCTION

This report is the fourth in the Bedford Institute of Oceanography data series "Wave Climate of the North Atlantic" (see Walker, 1976; Walker, 1977 and Walker, 1978) which is based on a continuous time series from 1970 to 1982.

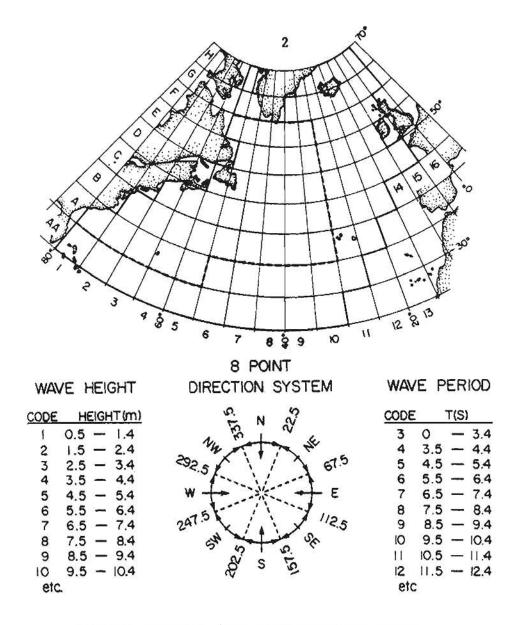
# WAVE DATA CHARTS

The data are derived from wave charts issued twice daily by the Canadian Forces Meteorological and Oceanographic Centre (METOC) in Halifax, N.S. These charts are based upon synoptic visual observations of waves from ships at sea and on data from weather ships and oil exploration/drilling rigs equipped with wave recorders.

As argued by Neu (1982) these waves reported are for all practical purposes significant waves, that is, their height is the mean of the highest one-third of all the waves during the observation, and their reported periods are about 10% less than the mean period of these one-third highest waves.

The study area from which the data were collected lies between latitudes 25 N and 70 N. Not included were the marginal seas, ocean embayments and the shallow areas of the coastal region in which waves are affected by shoaling, refraction and diffraction. The area around the Canary Islands was not included due to the scarcity of wave observations reported to METOC.

The study area is comprised of eighty-eight 5°x5° areas which include regions in coastal waters where the shore line infringes some grid areas. The entire study area is enclosed by a solid line shown in Figure 1.



NOTES: Direction - from which waves are coming.

Height - vertical distance from crest to trough.

Period - interval required for successive crests
or troughs to pass a fixed point.

Figure I. BIO Grid System and Code of Wave Properties

As observations of periods and directions of the waves reported in the METOC charts were less frequent in the eastern North Atlantic than in the western North Atlantic, reading of these properties was restricted to the thirty-nine 5°x5° areas of the western North Atlantic. This region is outlined by the dashed line shown in Figure 1.

## DATA PRESENTATION

In this report only the wave heights are presented. They are plotted by areas and months and by areas and years. The original data, which include periods and directions for the western North Atlantic, are on file at B.I.O. and may be obtained upon request.

## DATA READING

Wave height, period and direction were read at the centre of the 5° area. The height was determined to the nearest metre. The period was read in seconds while the direction was read in one of the eight 45° sectors, with the north sector extending from 337.5° to 22.5°.

When sea ice cover was in excess of 50% of an area's surface it was assumed that there were no waves.

## DATA SORTING

For this report, data have been sorted by height for each area and then grouped by month and by year for a complete time series for each of the 88 areas, 1970 through 1982. The number of observations was 9496.

# DISTRIBUTION PLOTS

Each probability x logarithmic graph has been expanded to permit extrapolation of the distribution plots to the 100 year extreme value of wave heights. Values of the 100 year lines are as follows:

Percentage Exceedance	Date Series	Probability
0.01613	13 years	99.99863
0.01667	31 day months	99.98387
0.01777	30 day months	99.98333
0.00137	28 day months	99.98223

## ACKNOWLEDGEMENT

I would like to thank the ship-borne observers who have shown considerable care and consistency in their reports and the staff of the Canadian Forces METOC Centre in Halifax, Nova Scotia who have maintained the quality control that has been vital to this report.

## REFERENCES

- NEU, H.J.A. 1982. 11-year Deep-Water Wave Climate of Canadian Atlantic
  Waters. Canadian Technical Report of Hydrography and Ocean
  Sciences No. 13, 1982.
- WALKER, R.E. 1976. Wave Statistics for the North Atlantic 1970. Bedford Institute of Oceanography, Data Series BI-D-76-3, Dartmouth, N.S.
- WALKER, R.E. 1977. Wave Statistics for the North Atlantic 1970. Bedford Institute of Oceanography, Data Series BI-D-77-1, Dartmouth, N.S.
- WALKER, R.E. 1978. Wave Statistics for the North Atlantic 1972. Bedford Institute of Oceanography, Data Series BI-D-78-2, Dartmouth, N.S.

DISTRIBUTION PLOTS

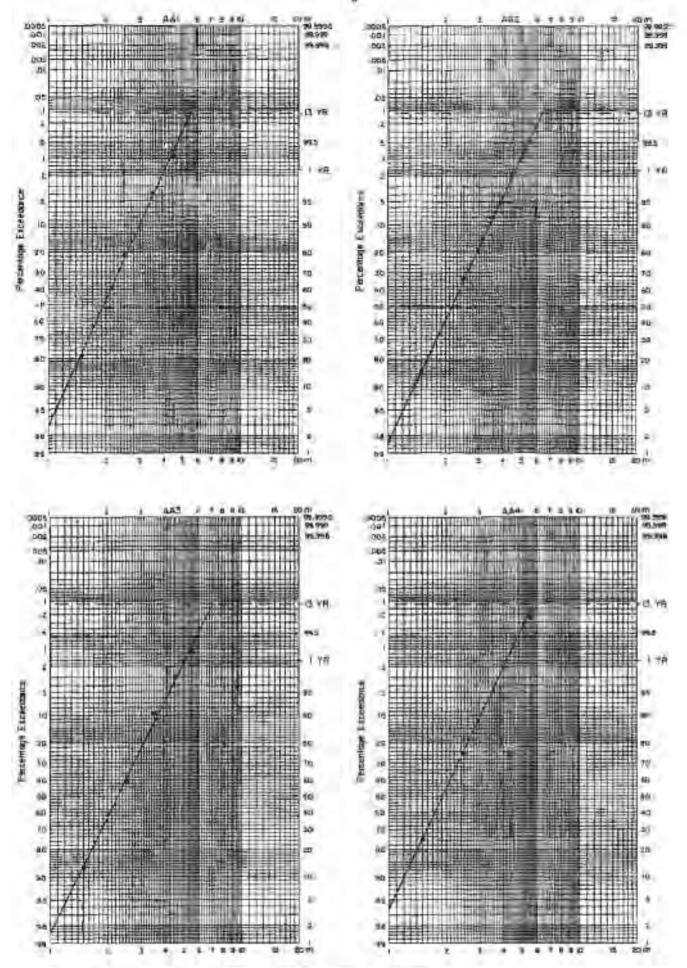


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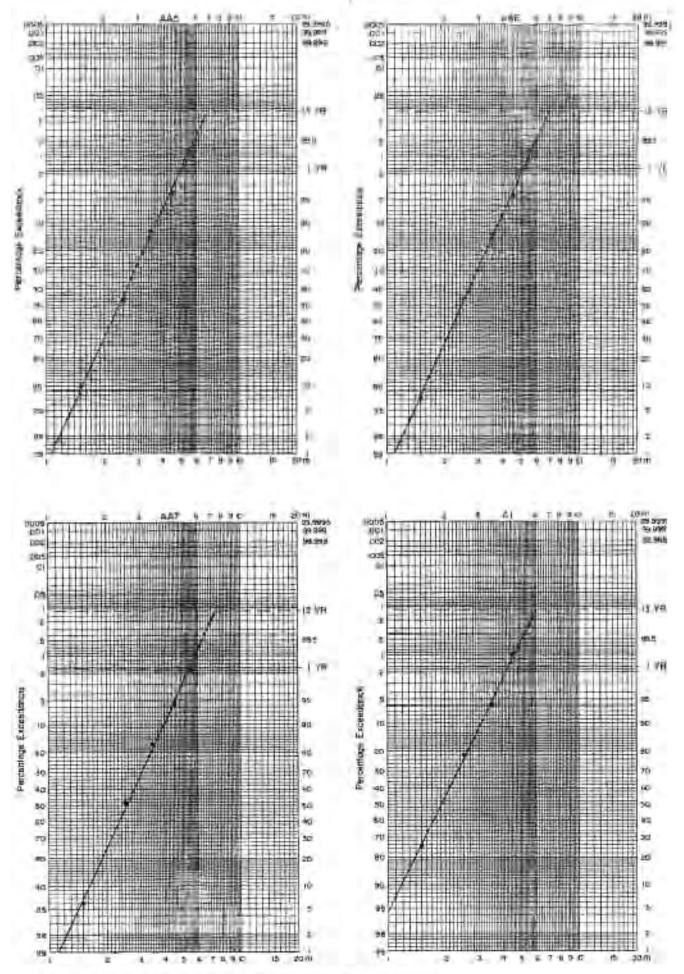


Figure Ib. Monthly Wave Height Exceedance Distribution for January



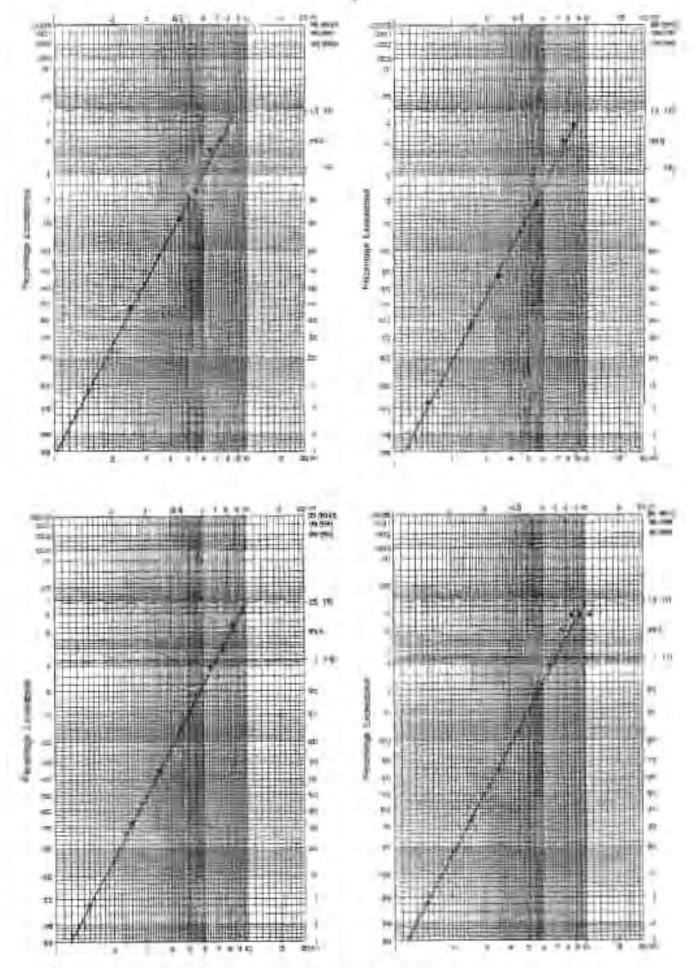


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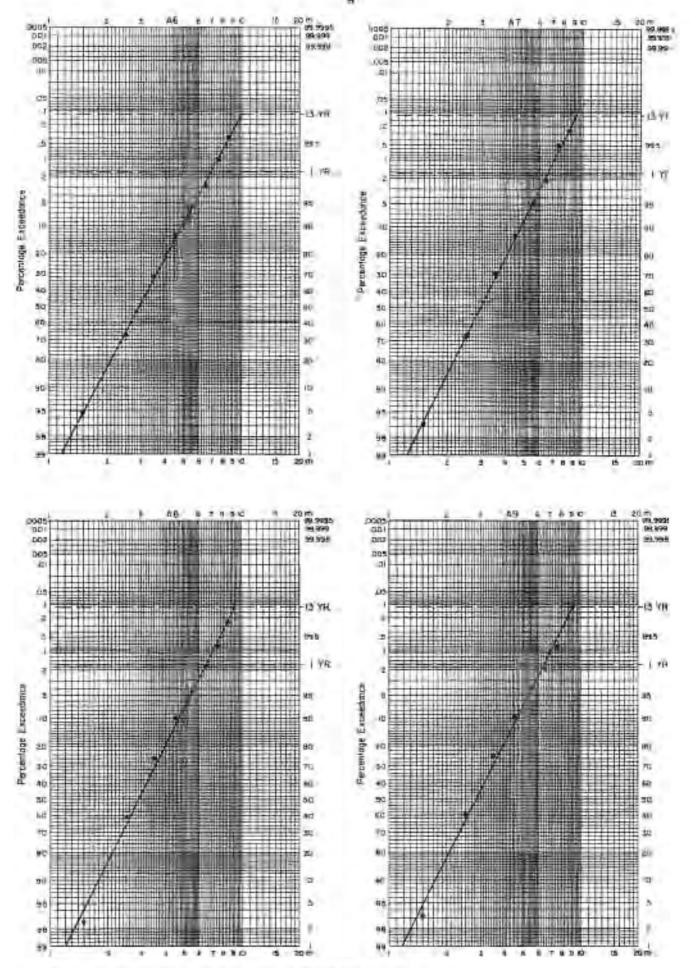


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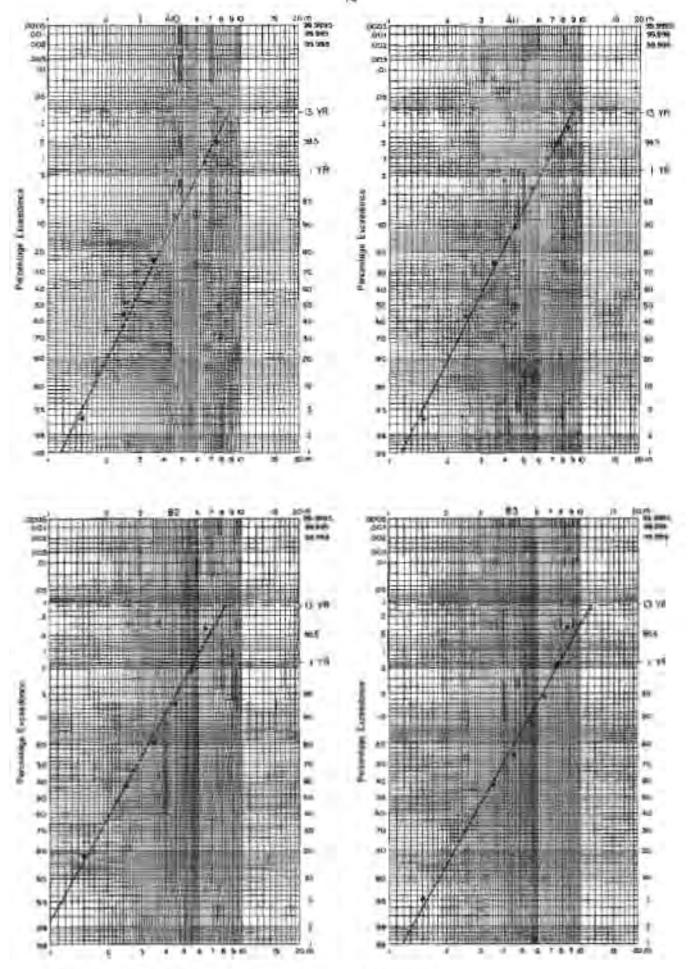


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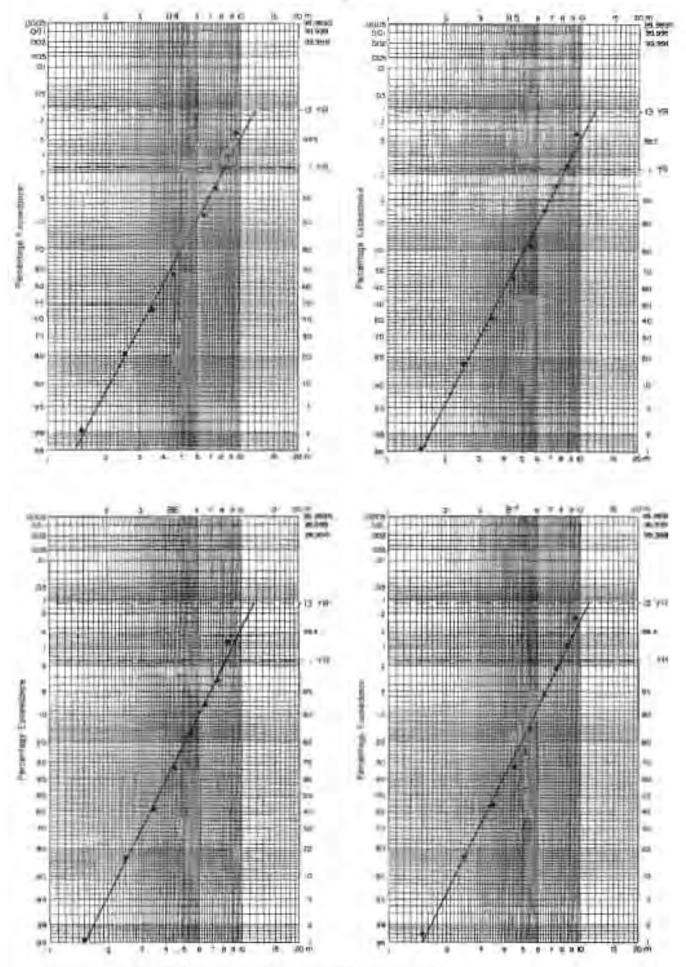


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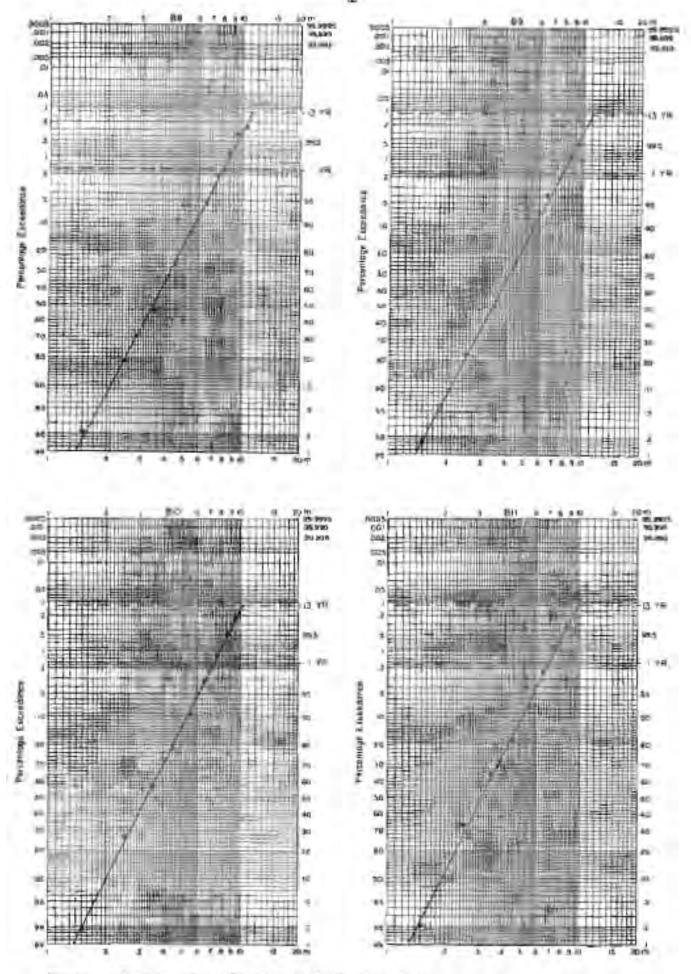


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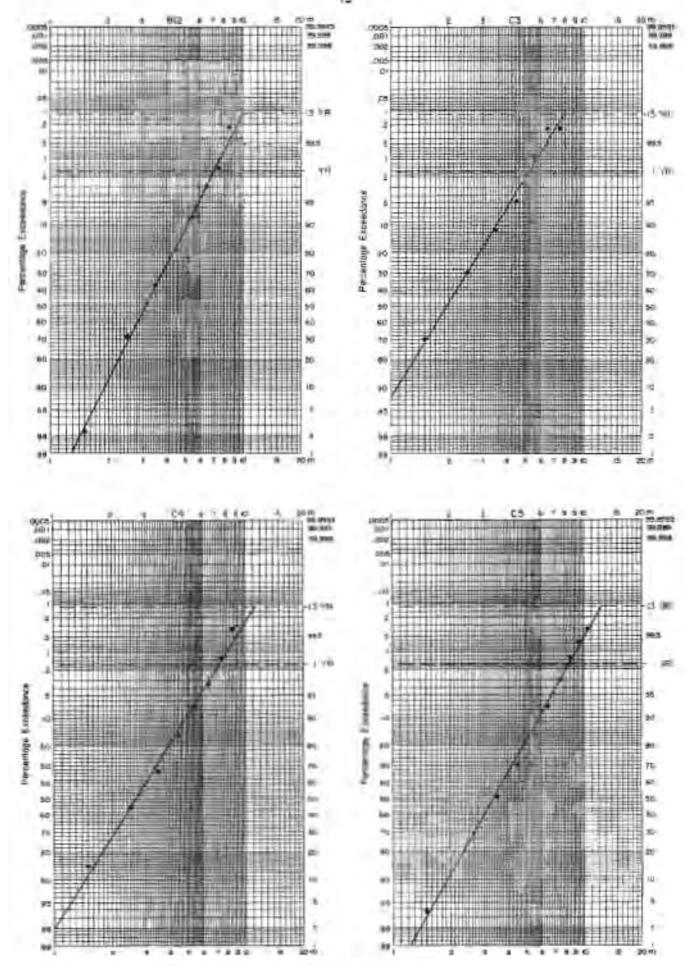


Figure in Monthly Wave Height Exceedance Distribution for January

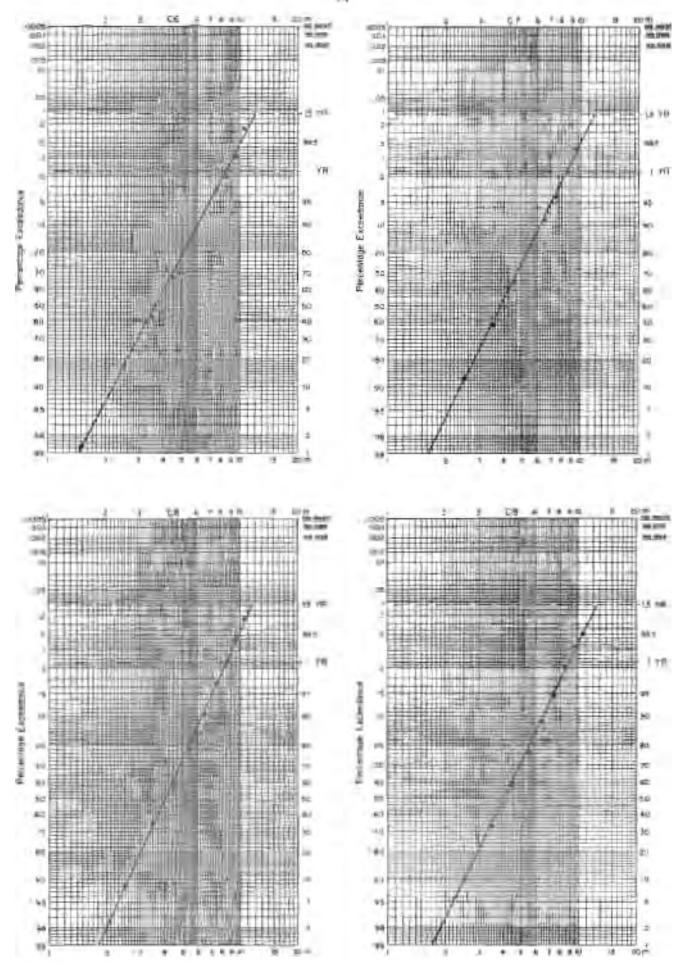


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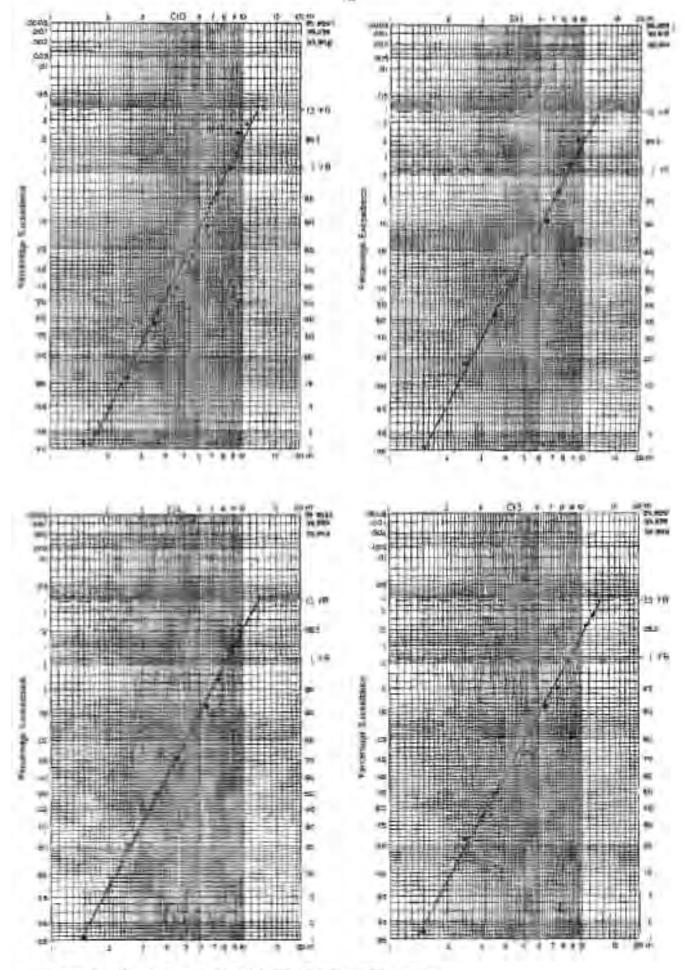


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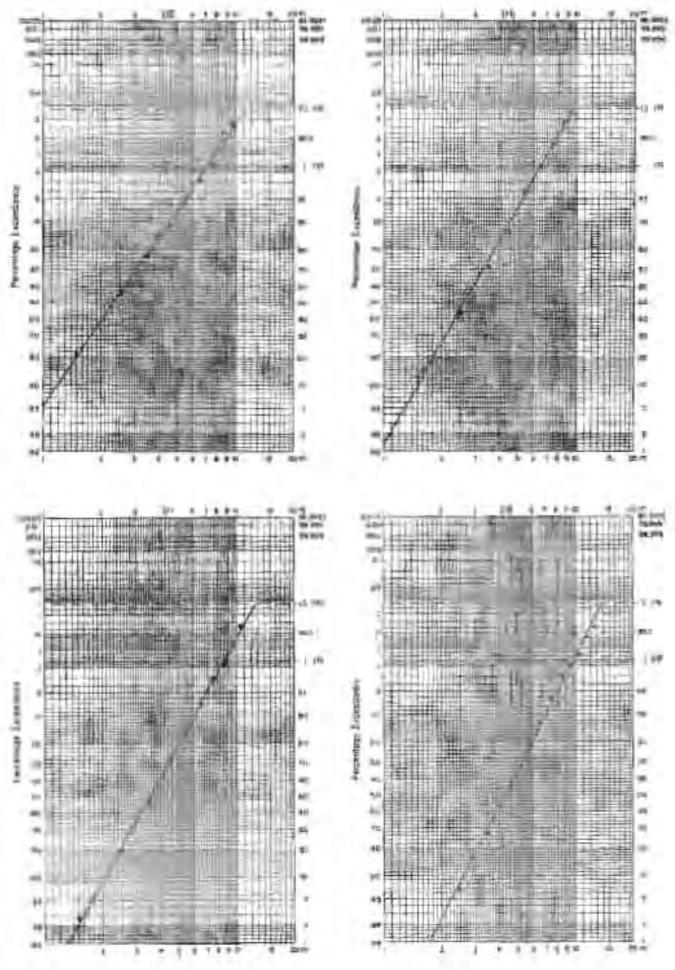


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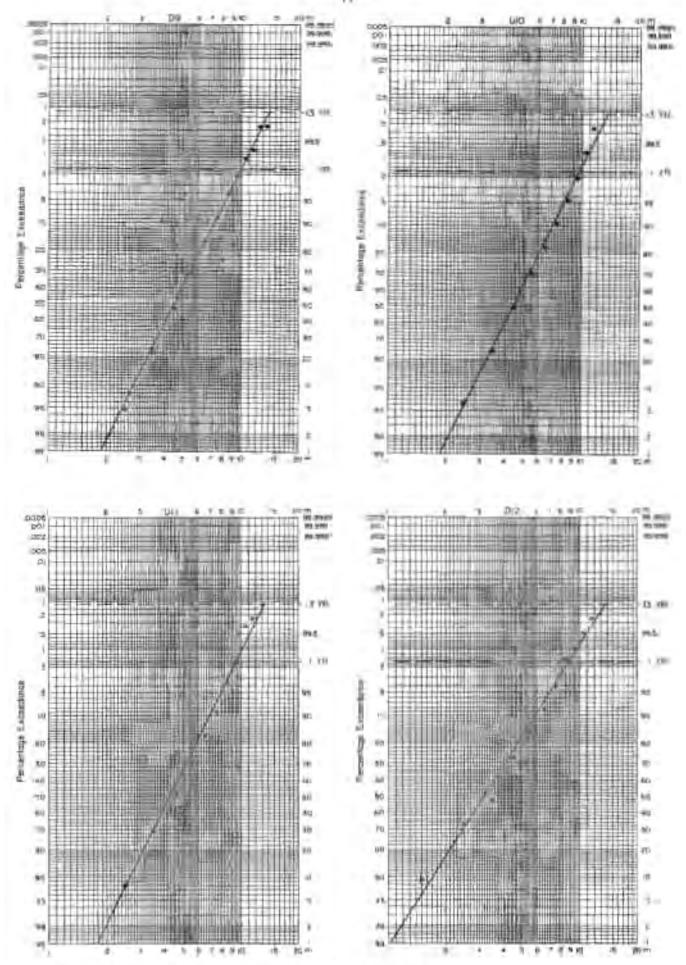


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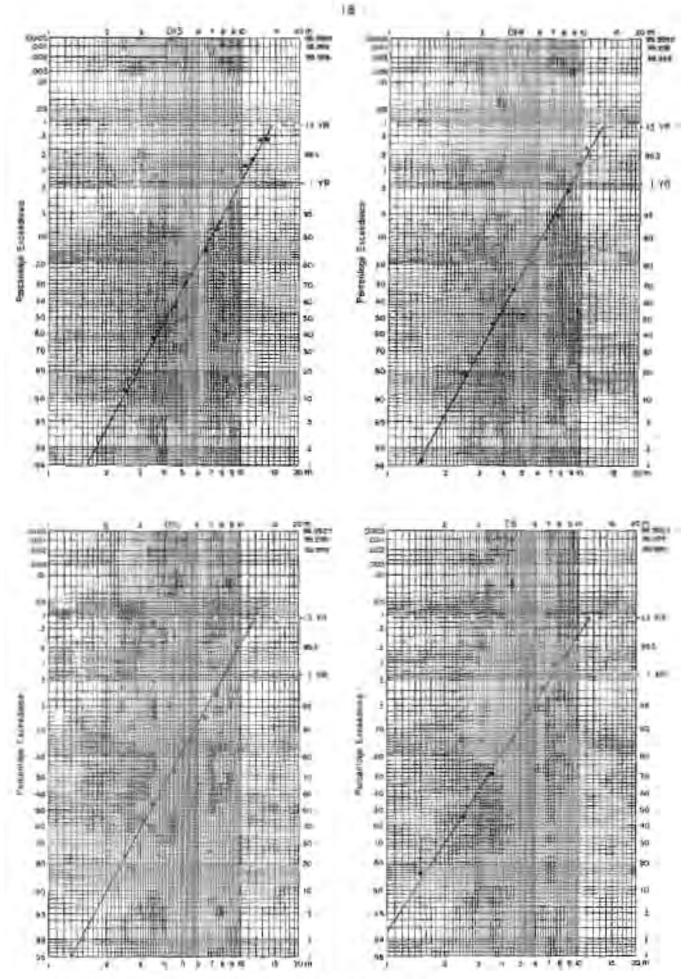


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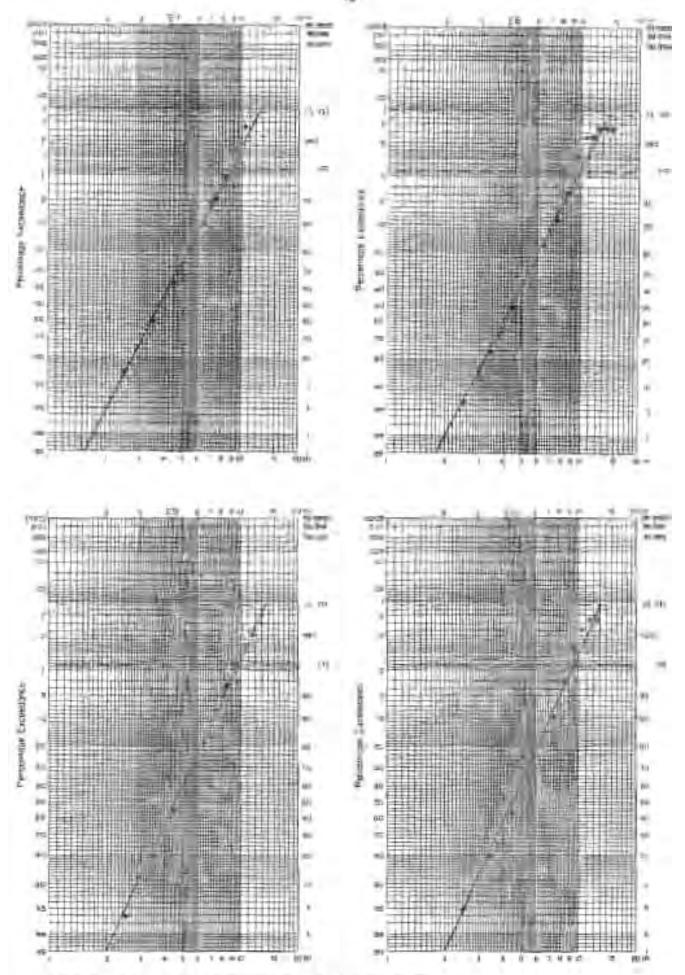
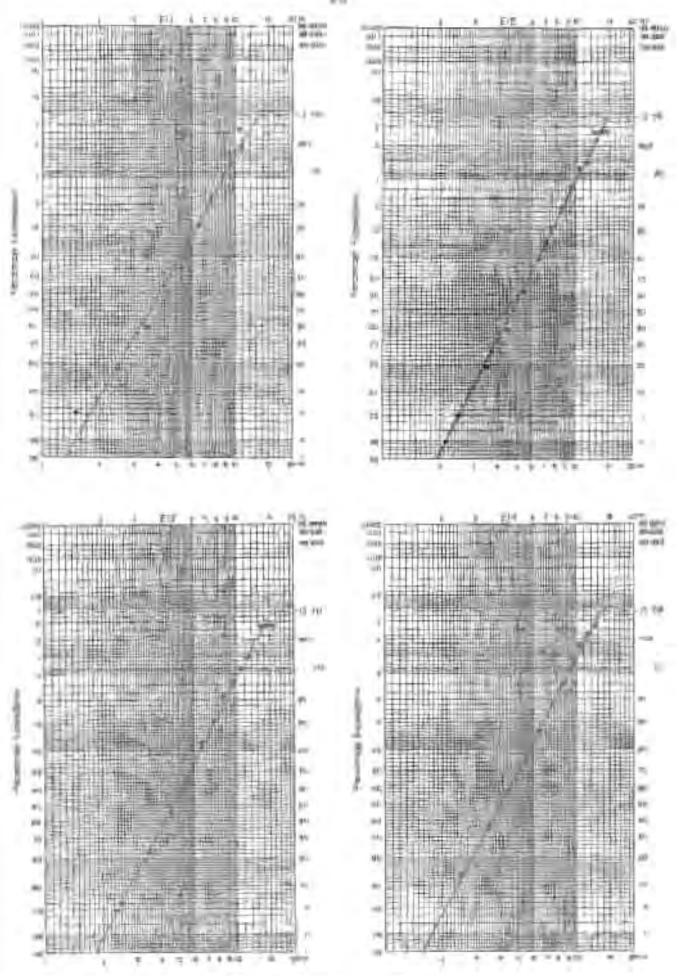
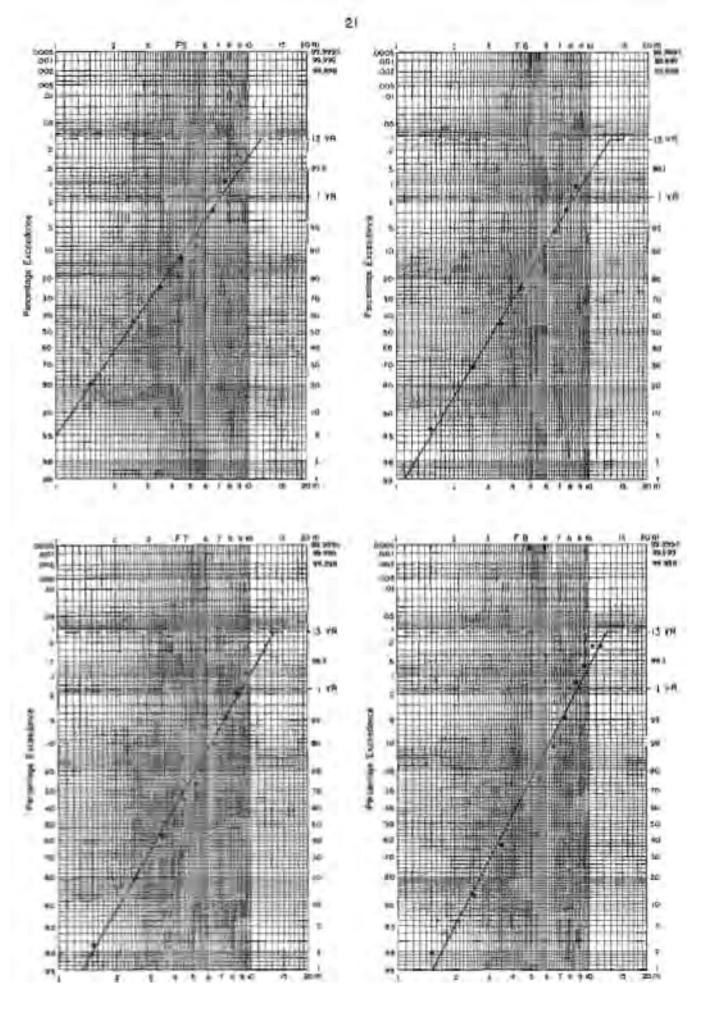
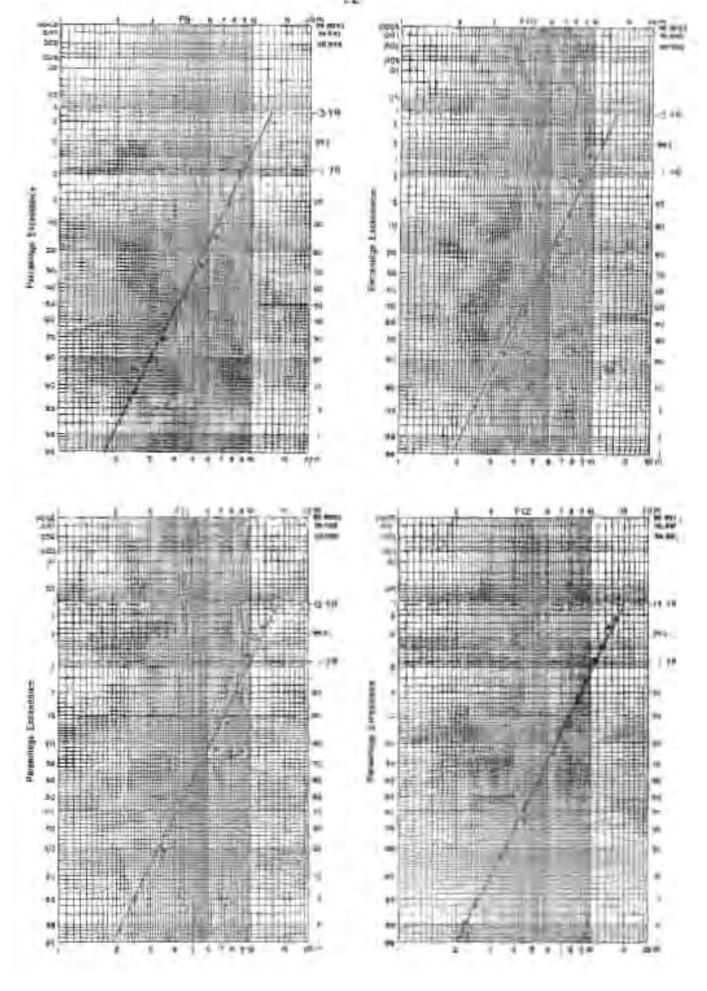


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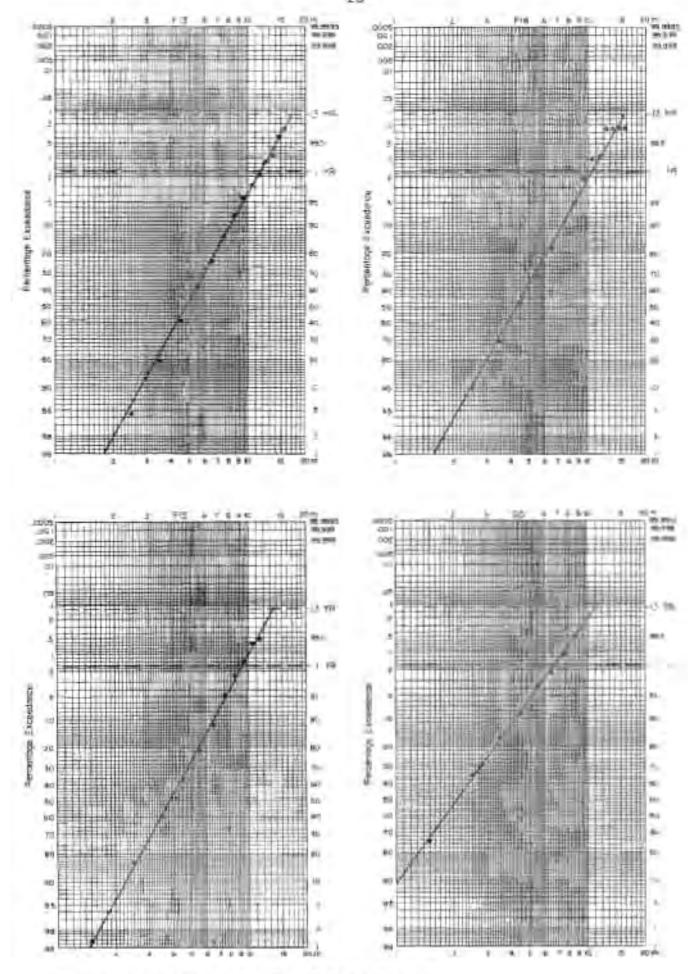


Figure II Monthly Wave Height Exceedance Distribution for January

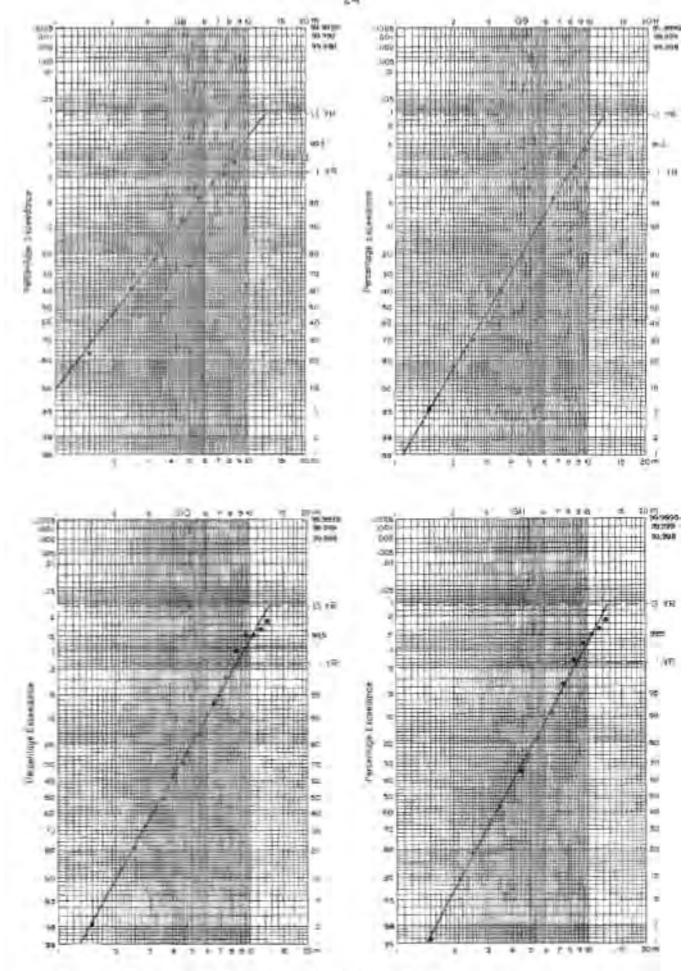
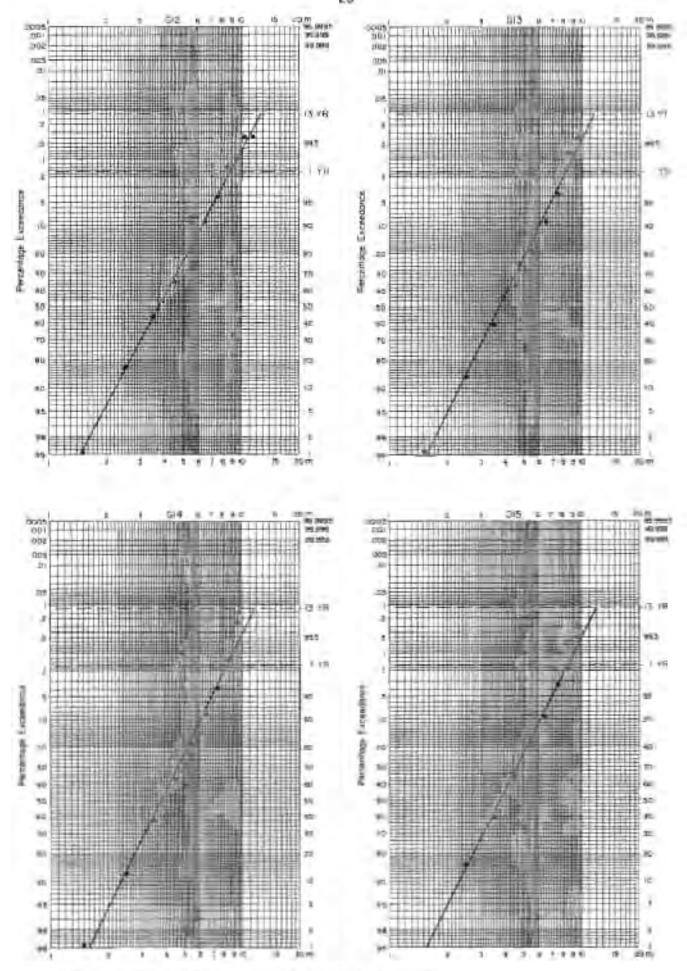


Figure Is: Monthly Wave Height Exceedance Distribution for January



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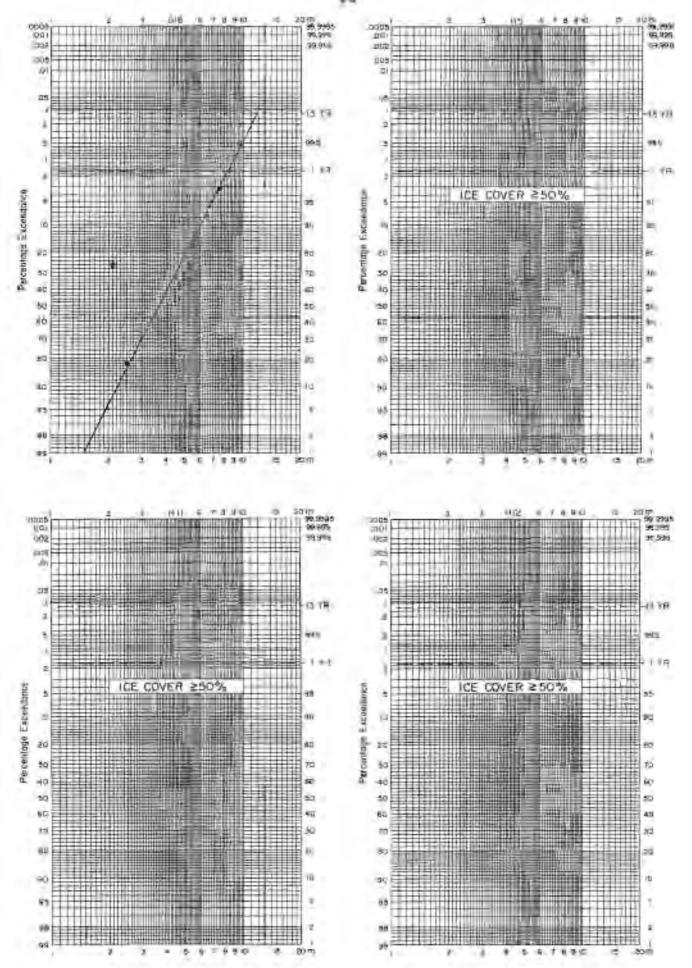
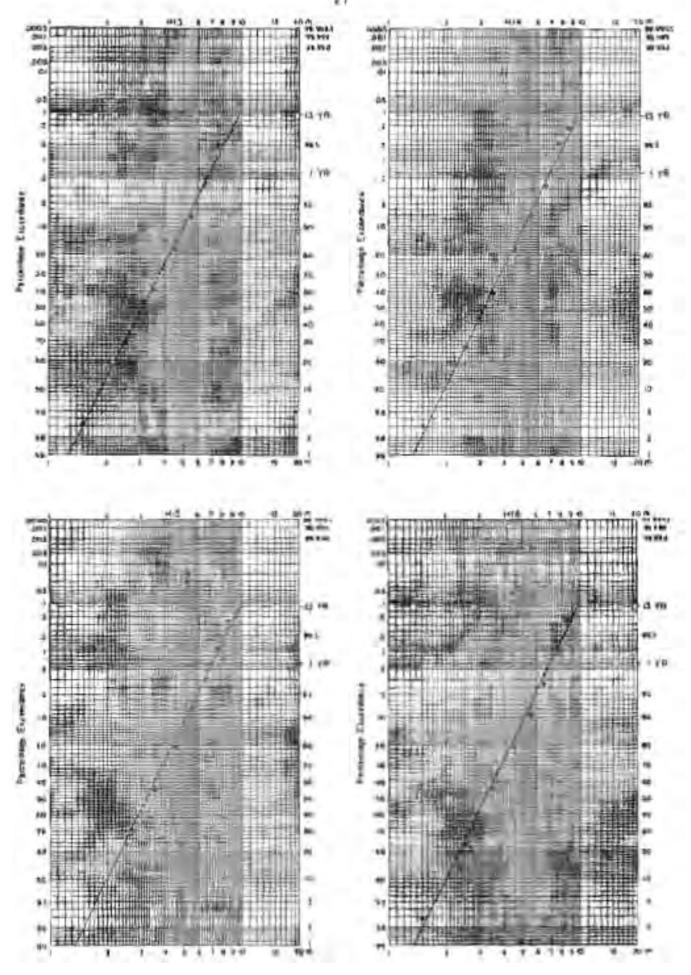


Figure IV Monthly Wave Height Exceedance Distribution for January



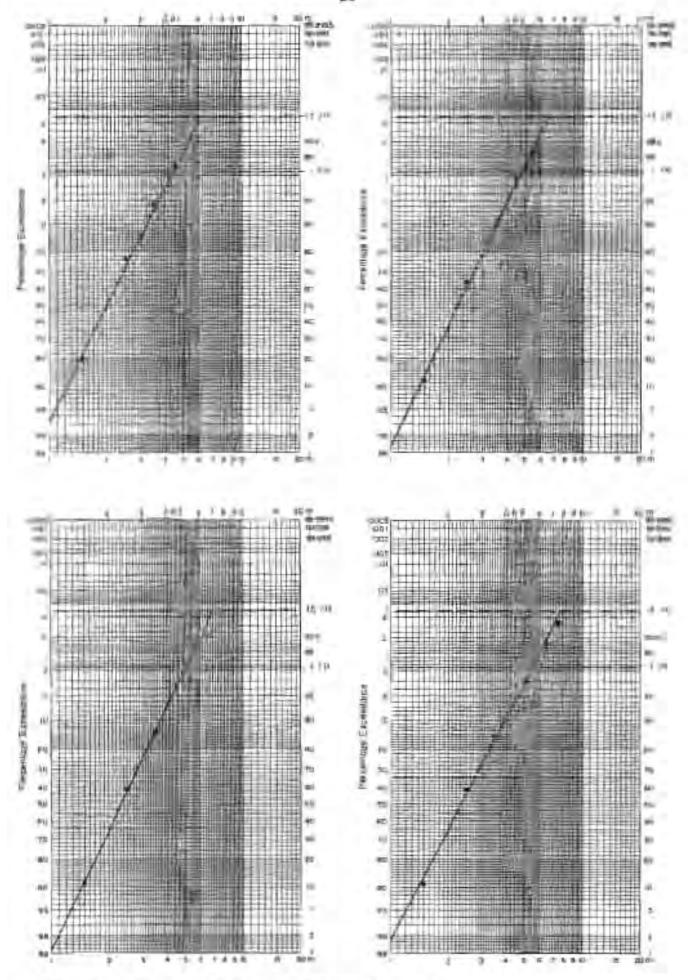
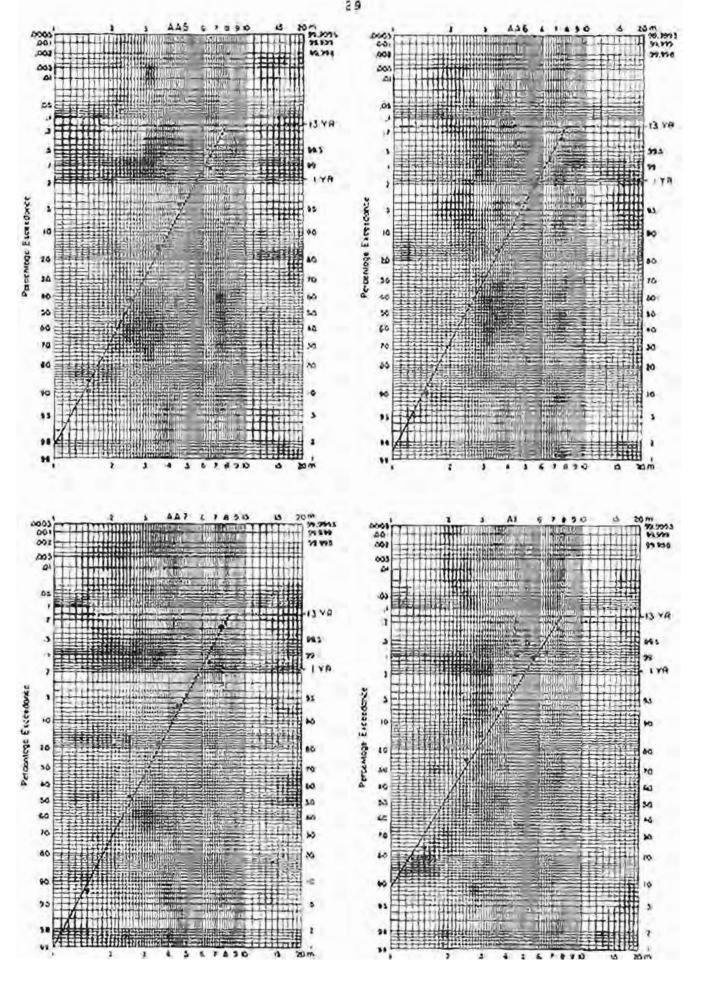


Figure 26: Monthly Wayer League Extensioned Chambleson for February



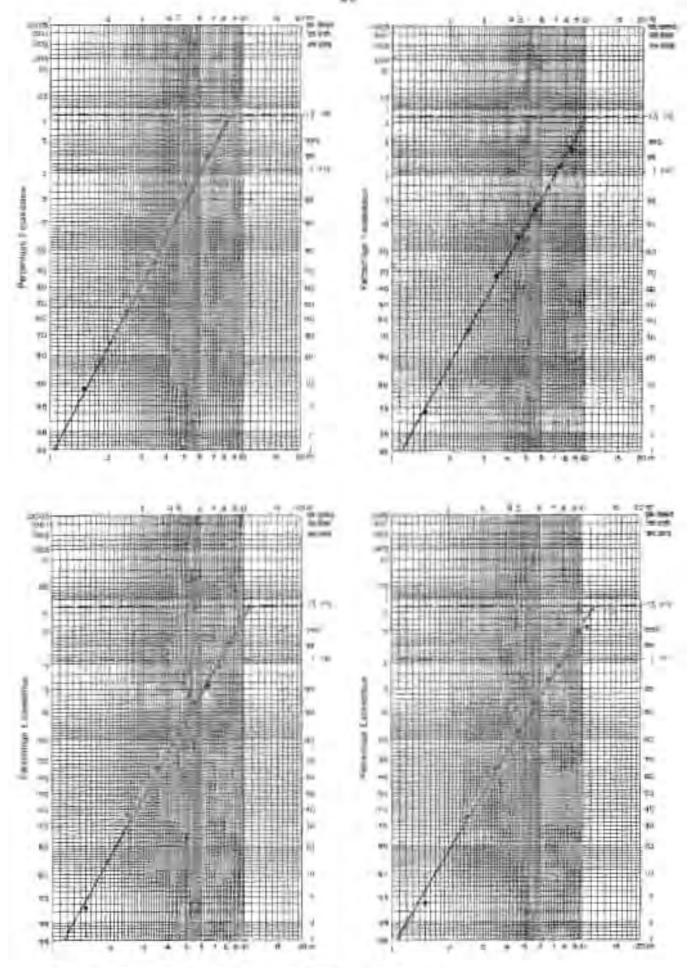
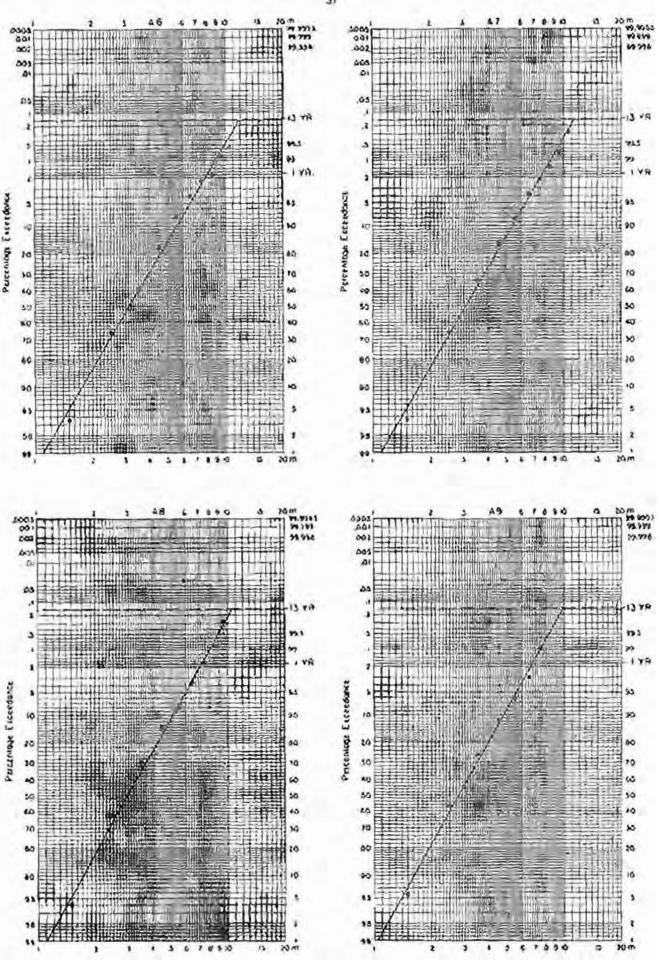


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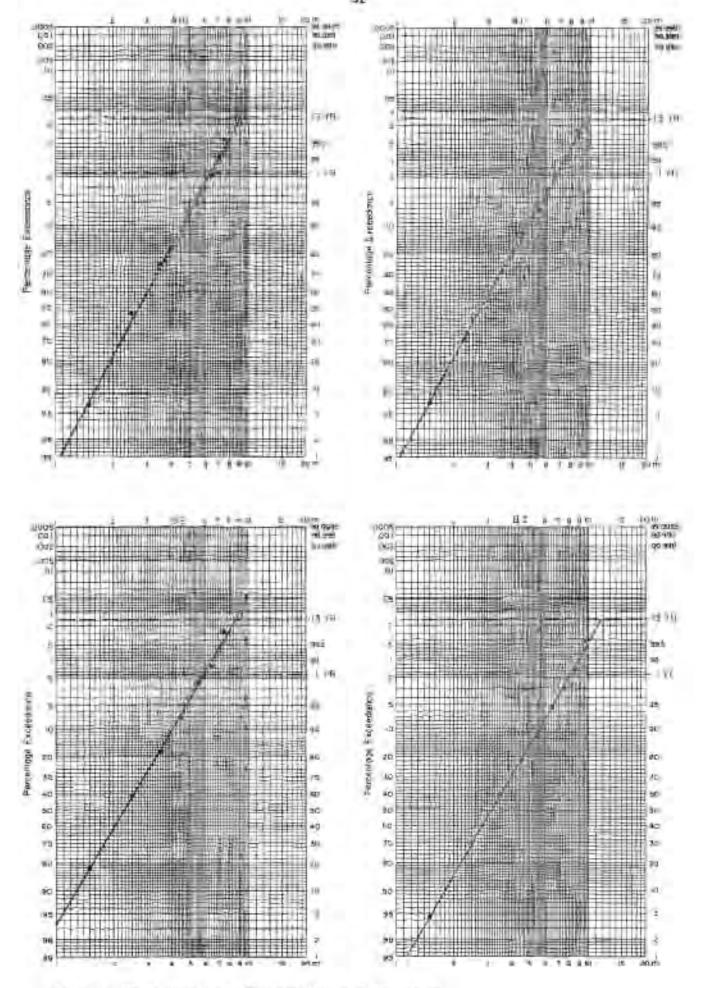
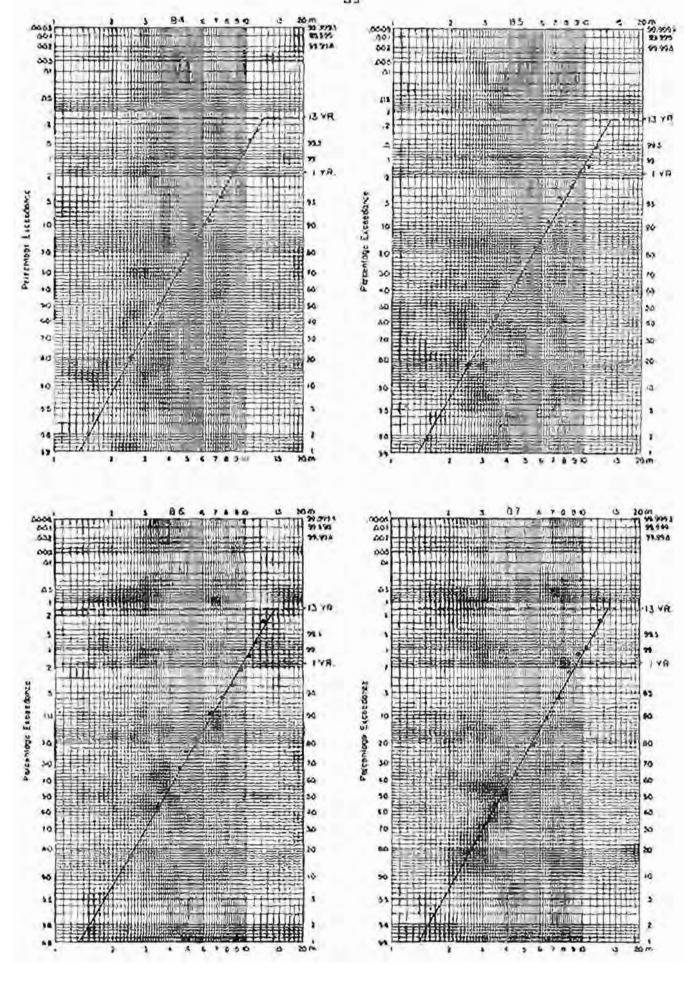


Figure 2r. Monthly Wave Holant Exceedance Distribution for February



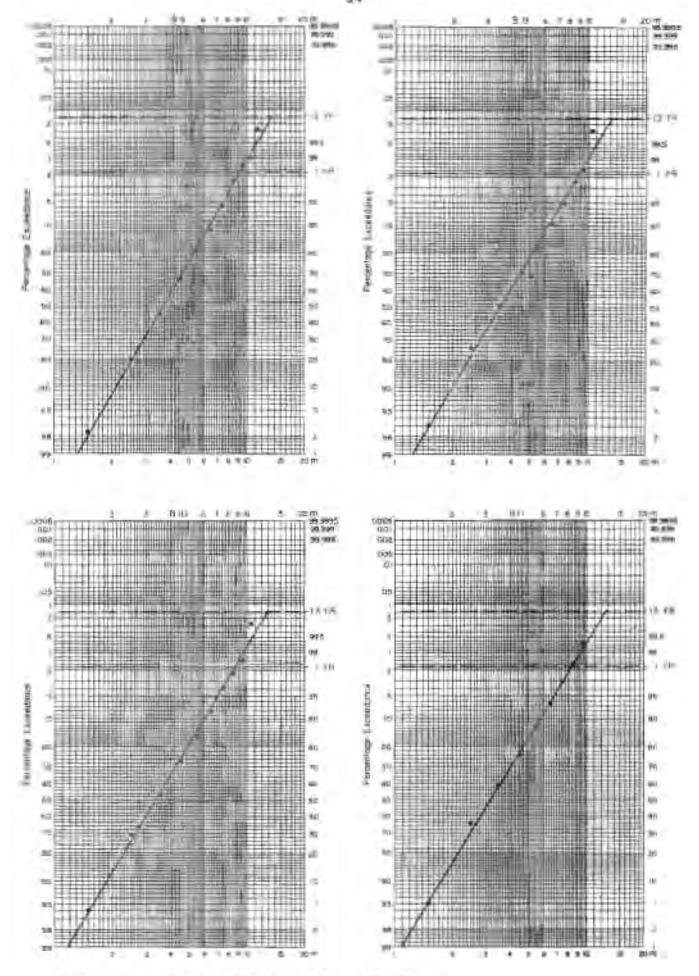


Figure 24 Monthly Wove resign Excessionica Distribution for Fabruary

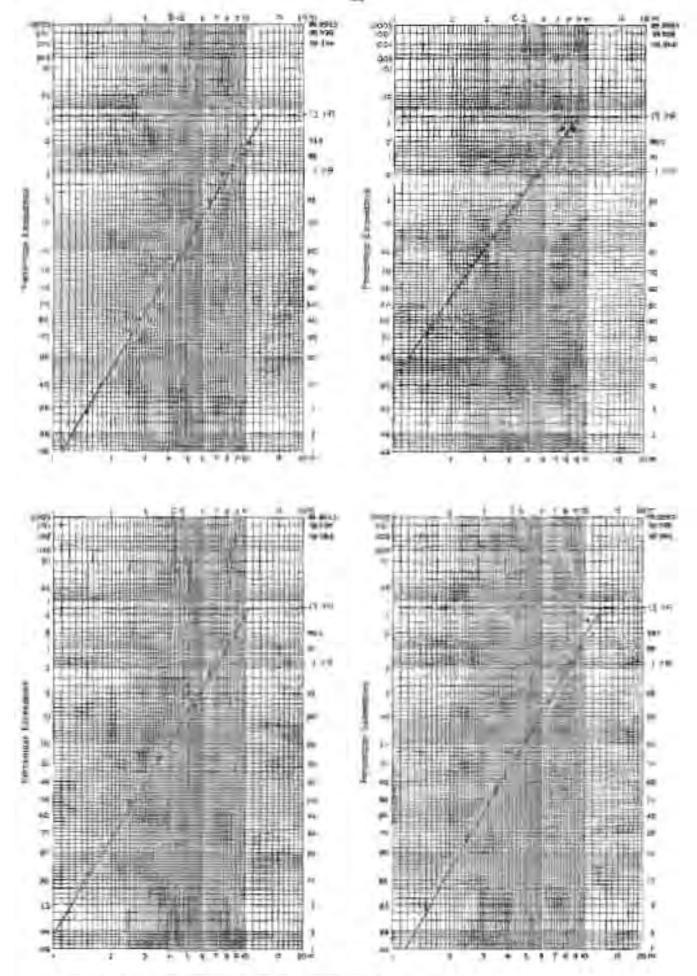


Figure 28. Monthly Wave Meight Exceedance Distribution for February

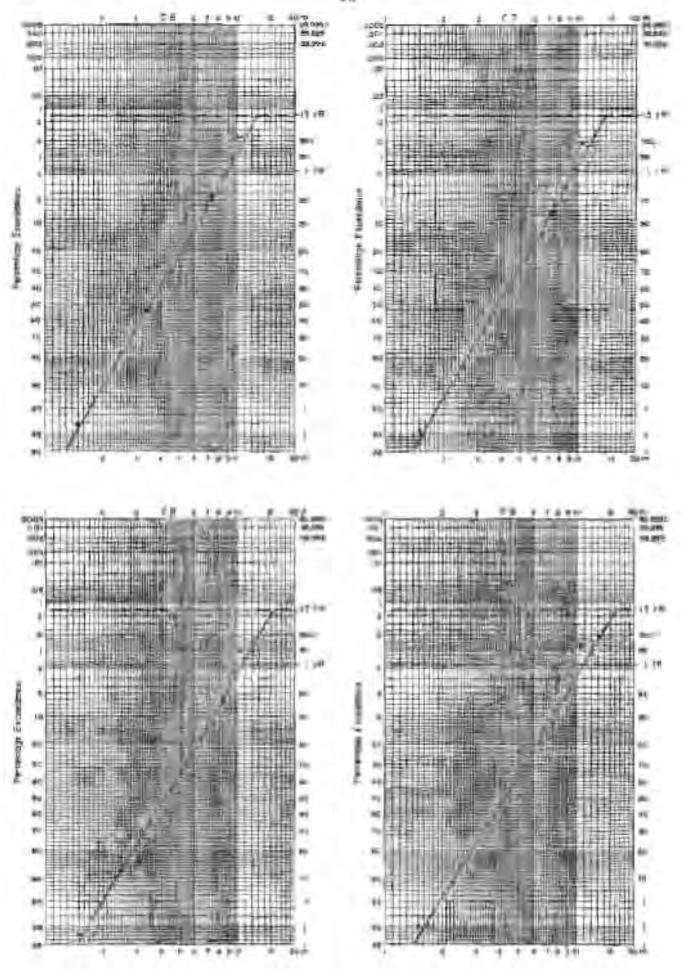


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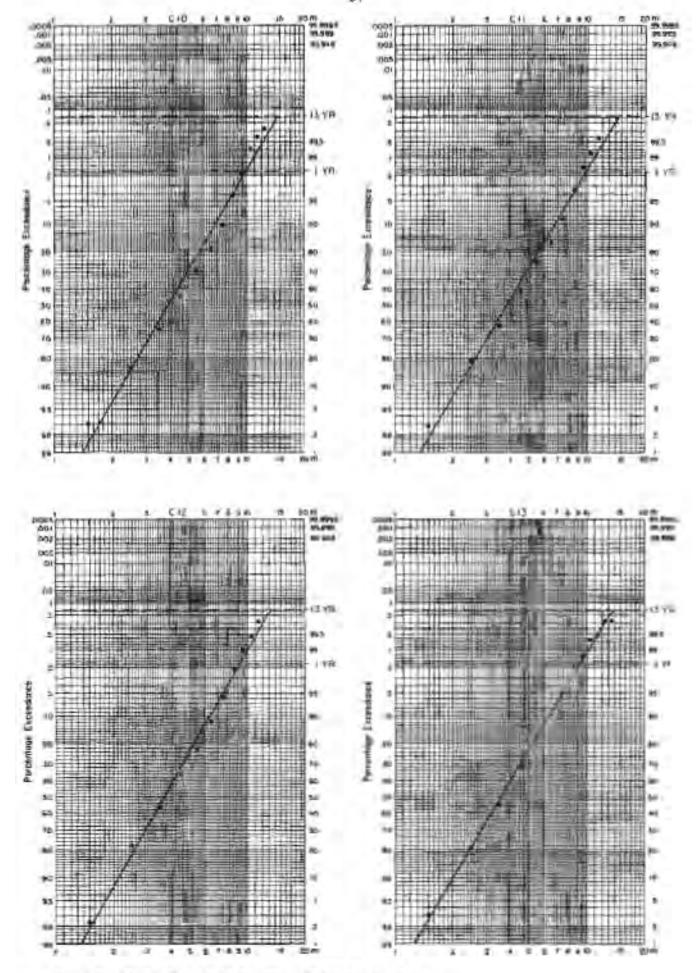


Figure 21. Markhly Wave Height Exceedance Distribution for Features

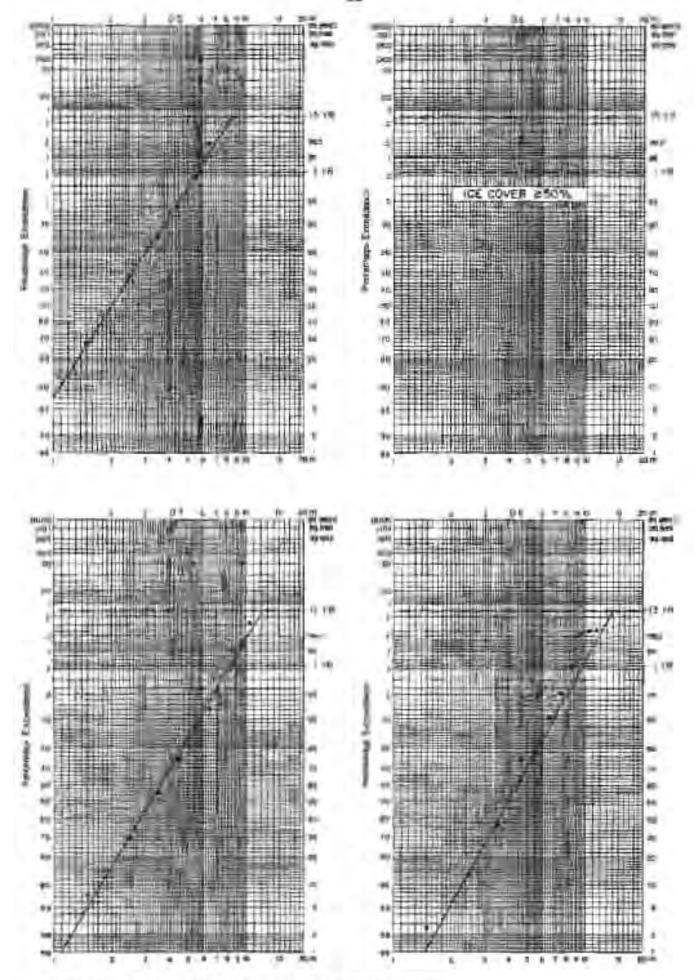


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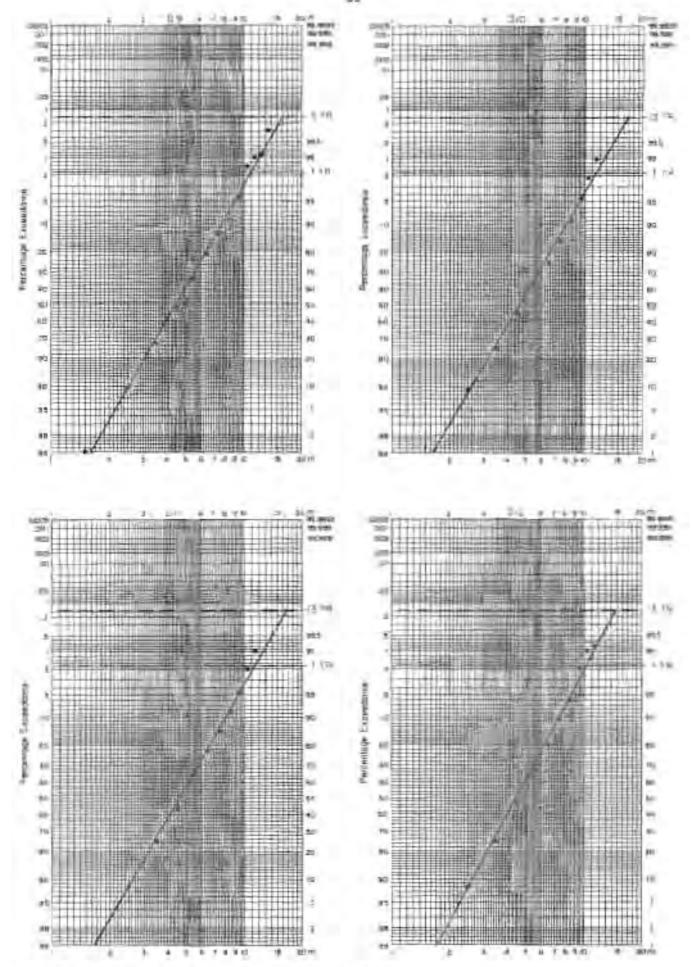


Figure D. Monthly Wave Height Exceedance Distribution for February

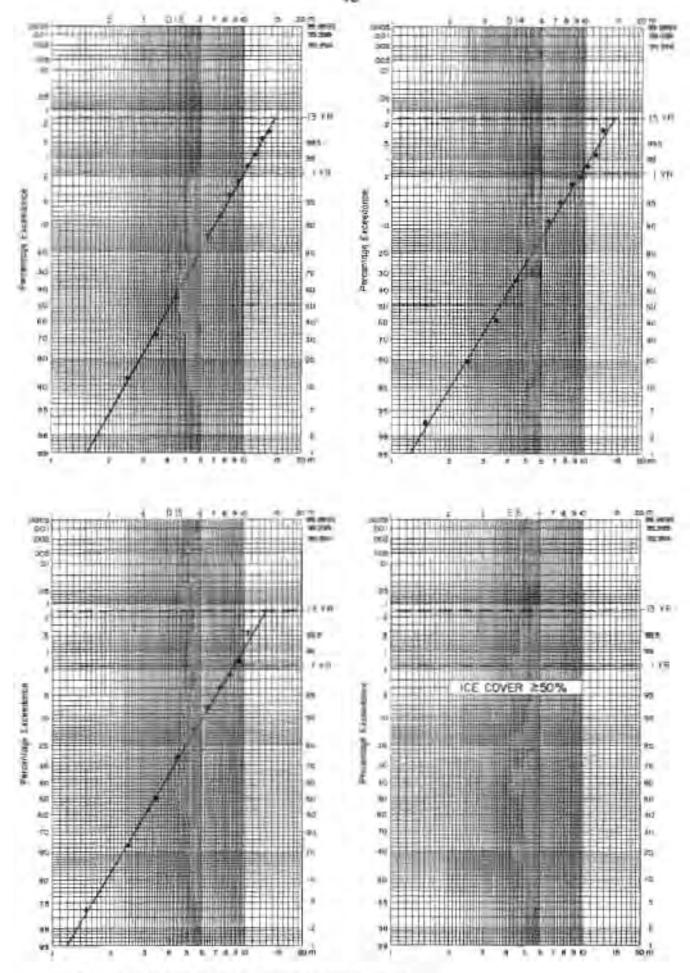
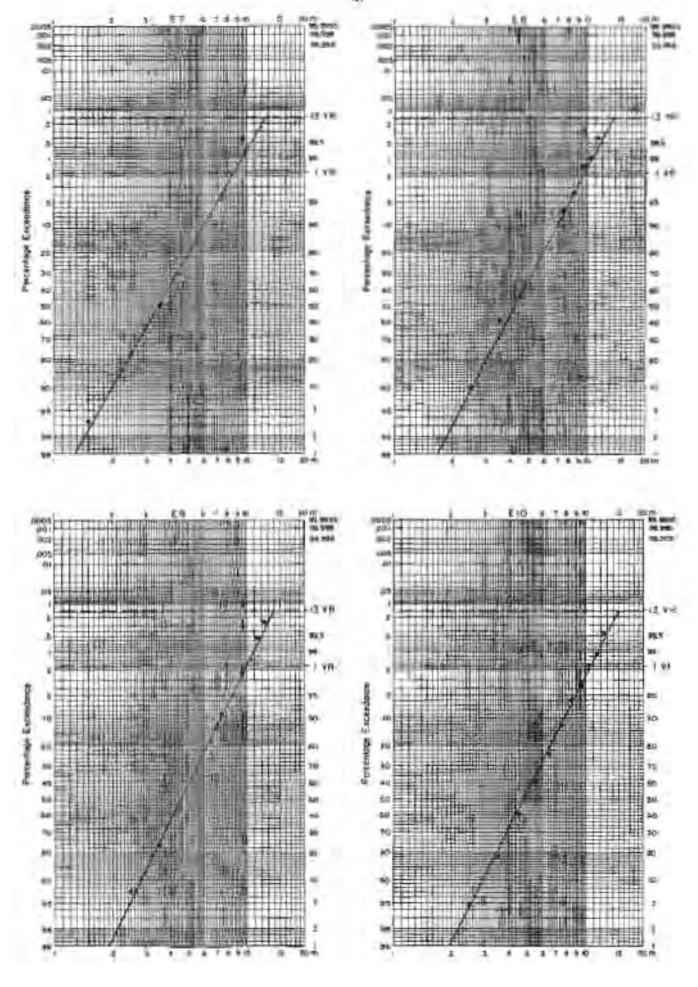


Figure 2m Monthly Wave Height Exceedance Distribution for February



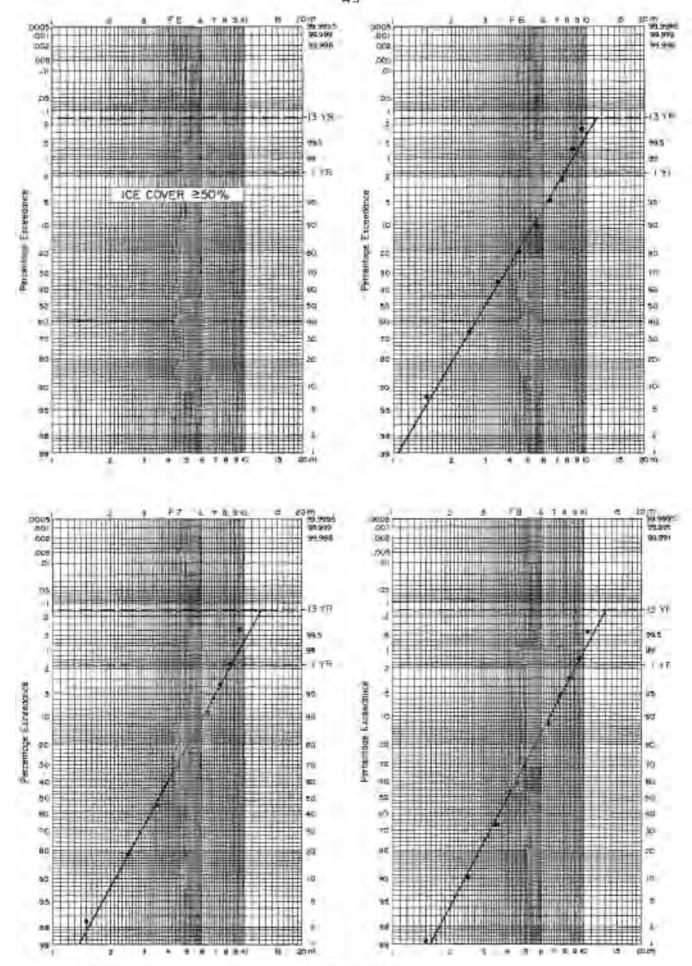


Figure Zo. Monthly Wave Height Exceedance Distribution for February

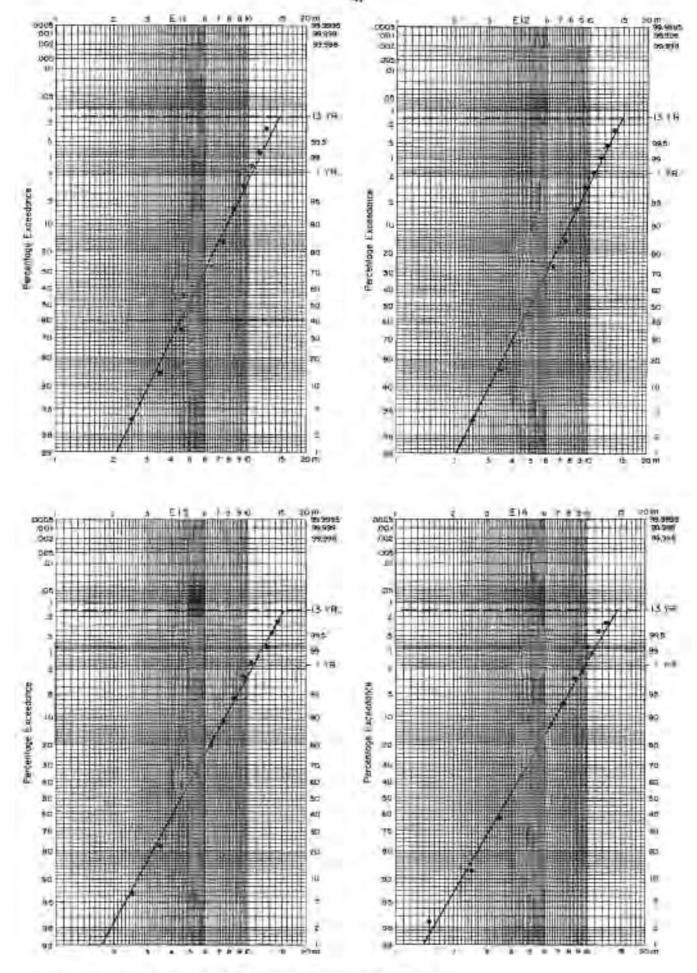
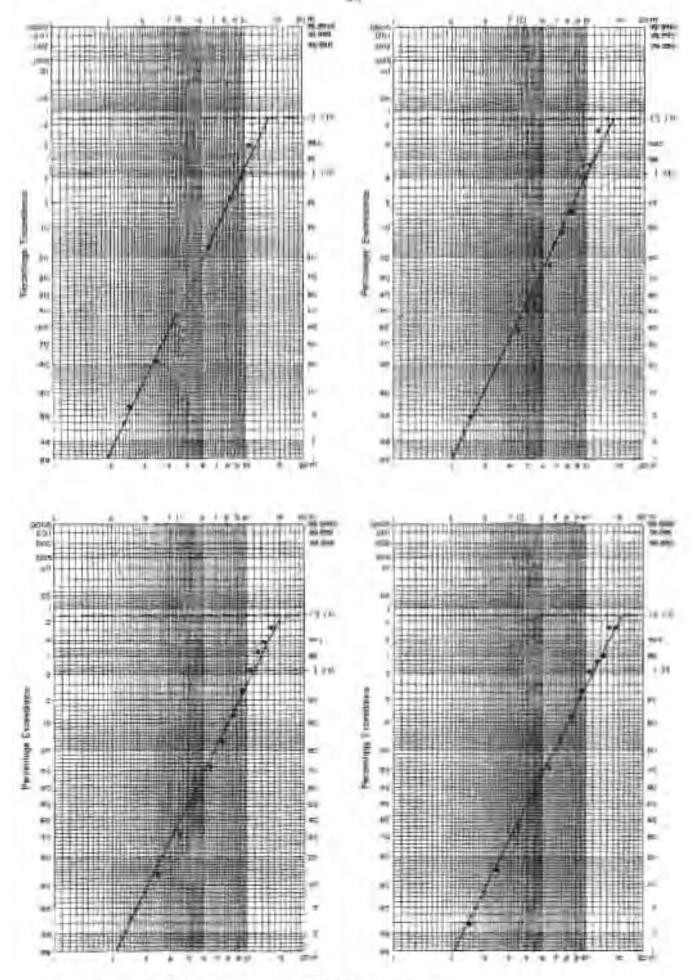


Figure 20 Monthly Wave Height Exceedance Distribution for February



Figury 24. Movilly Wave Height Exceedance Distribution for Fictions



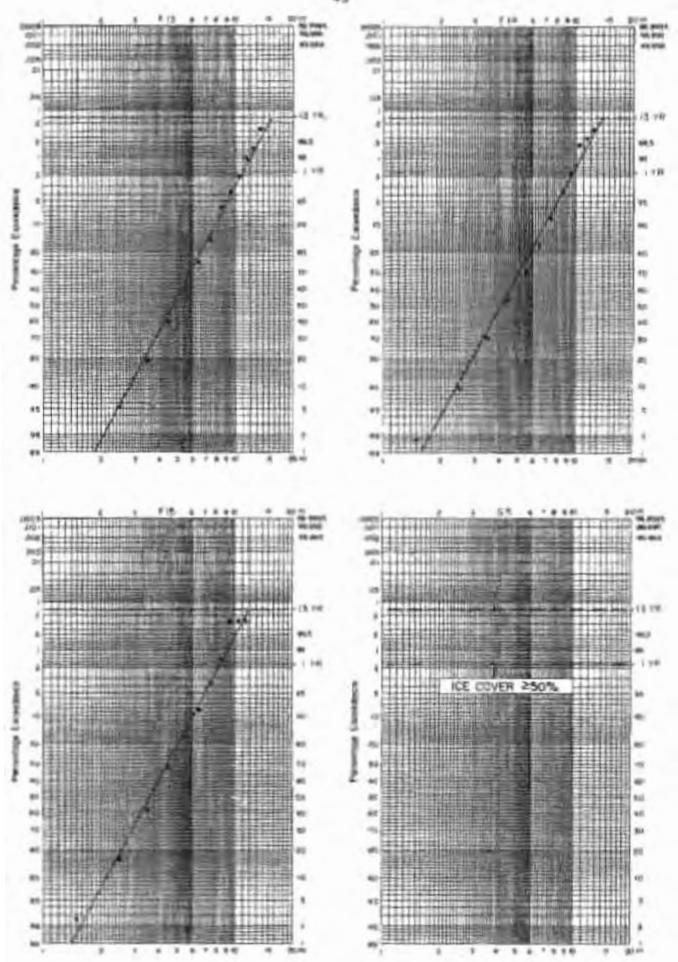


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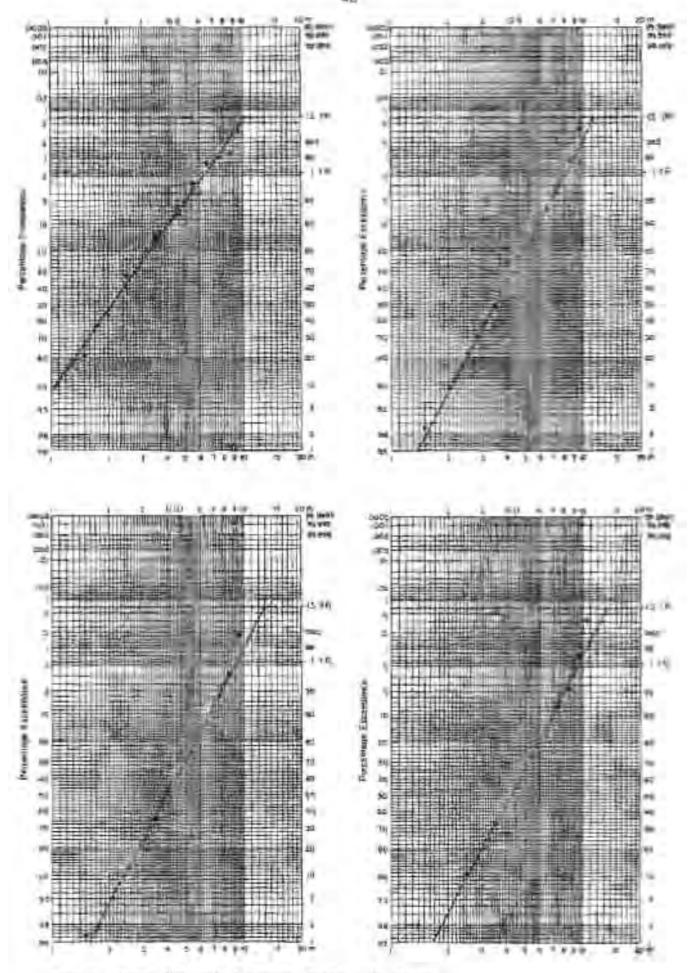


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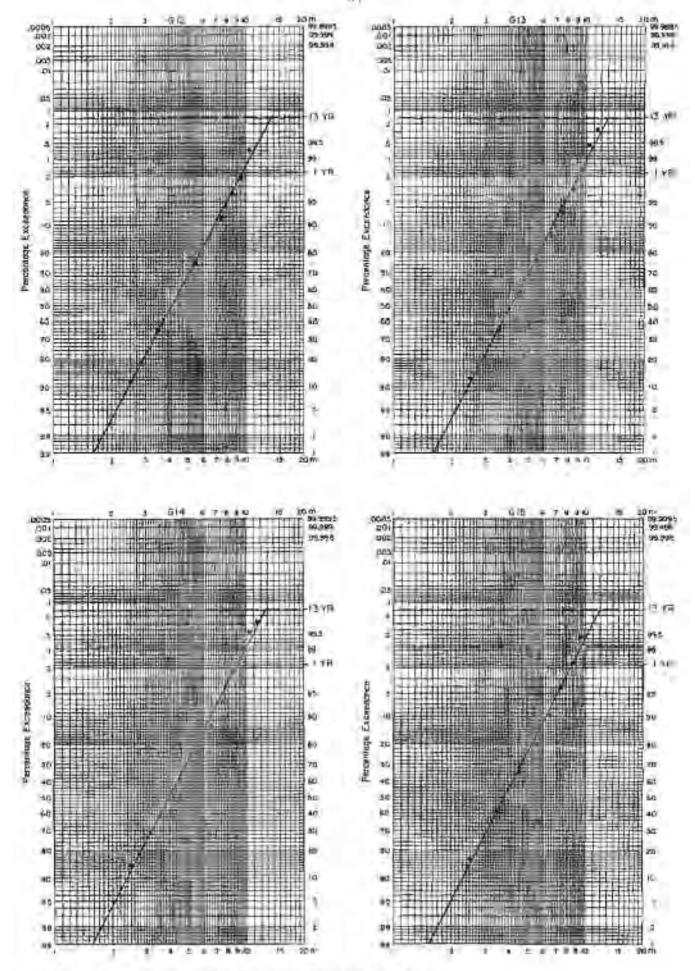


Figure 24 Monthly Wave Height Exceedance Distribution for February

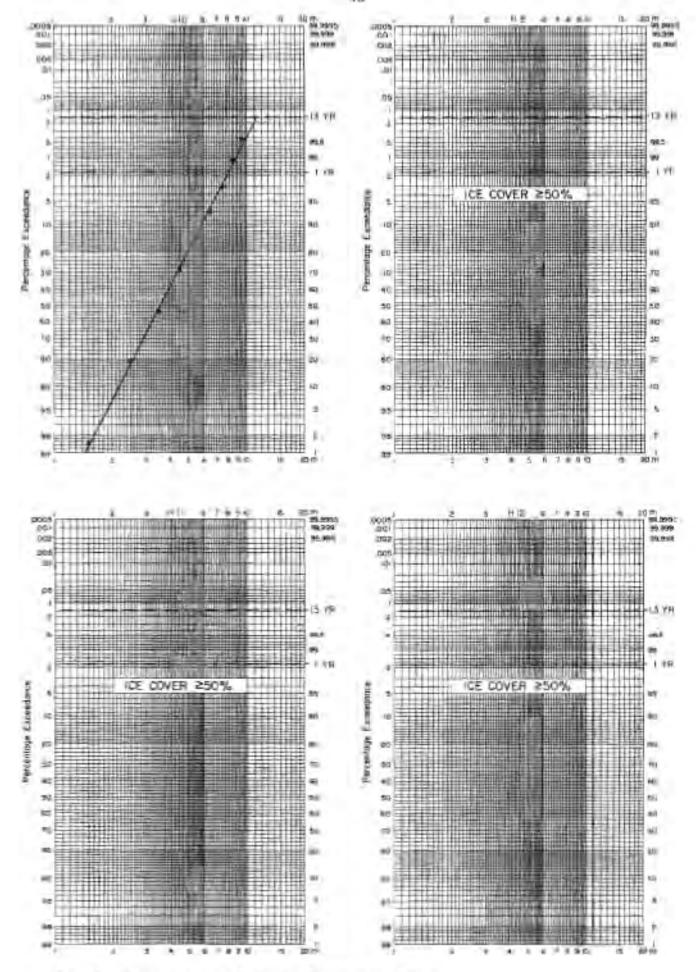
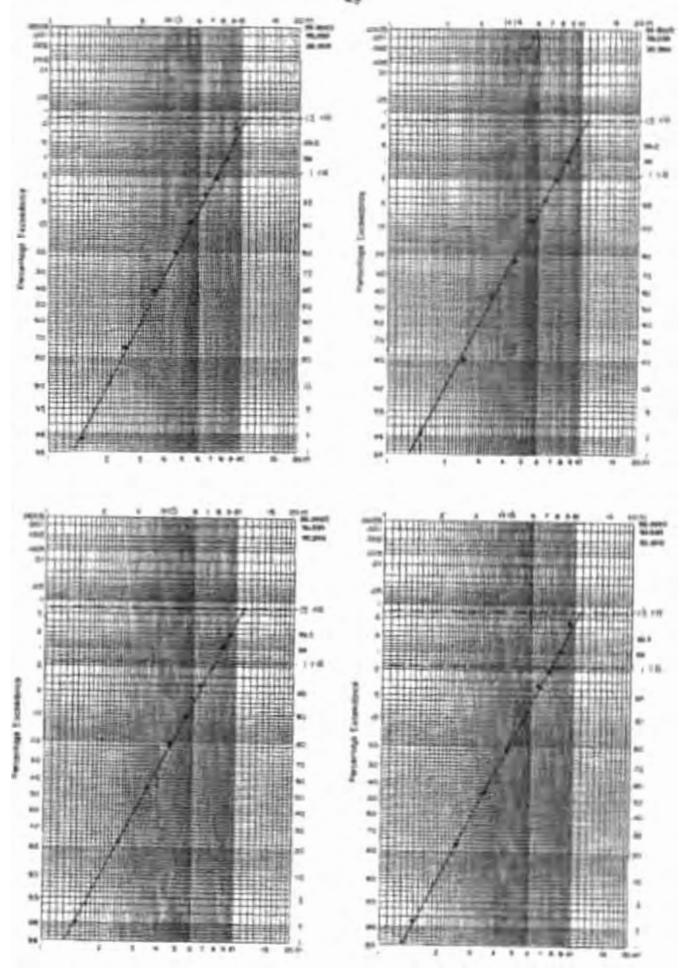
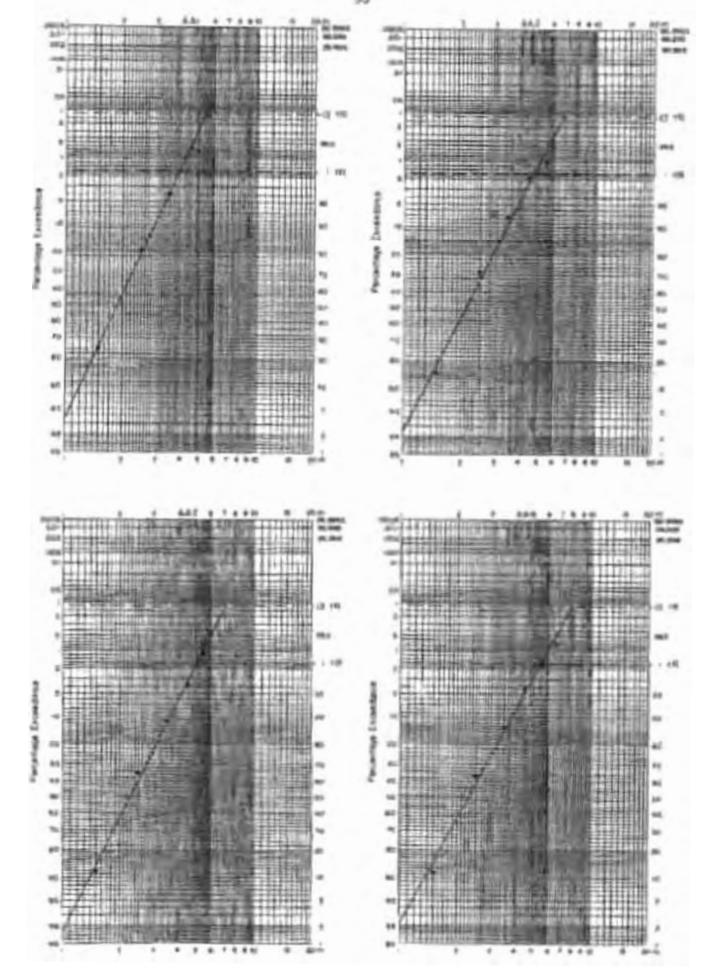


Figure 2u. Morning Wave meight Exceedance Distribution for February







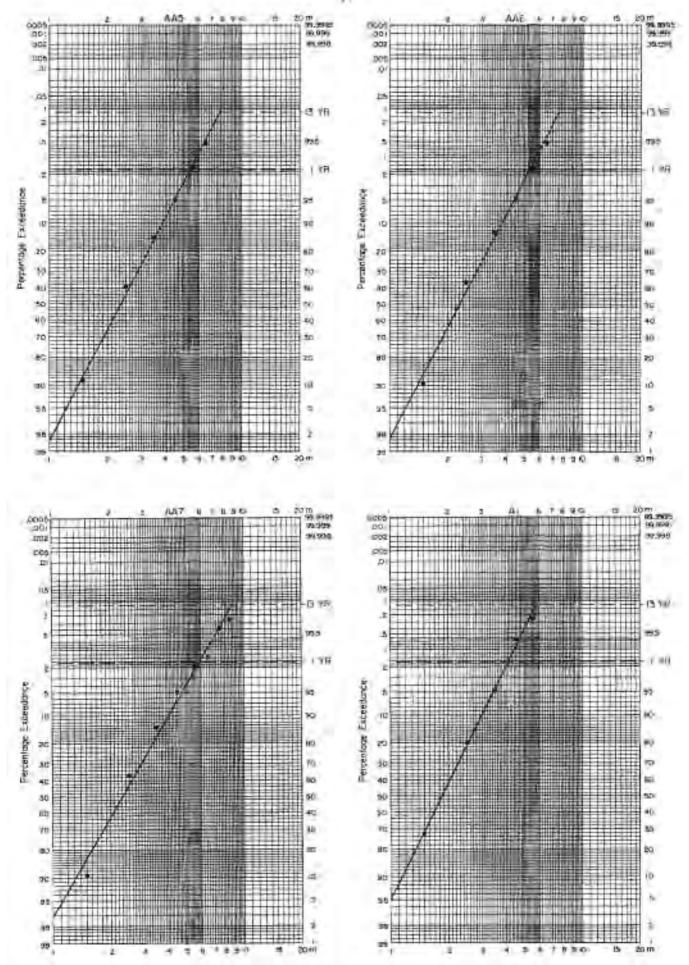
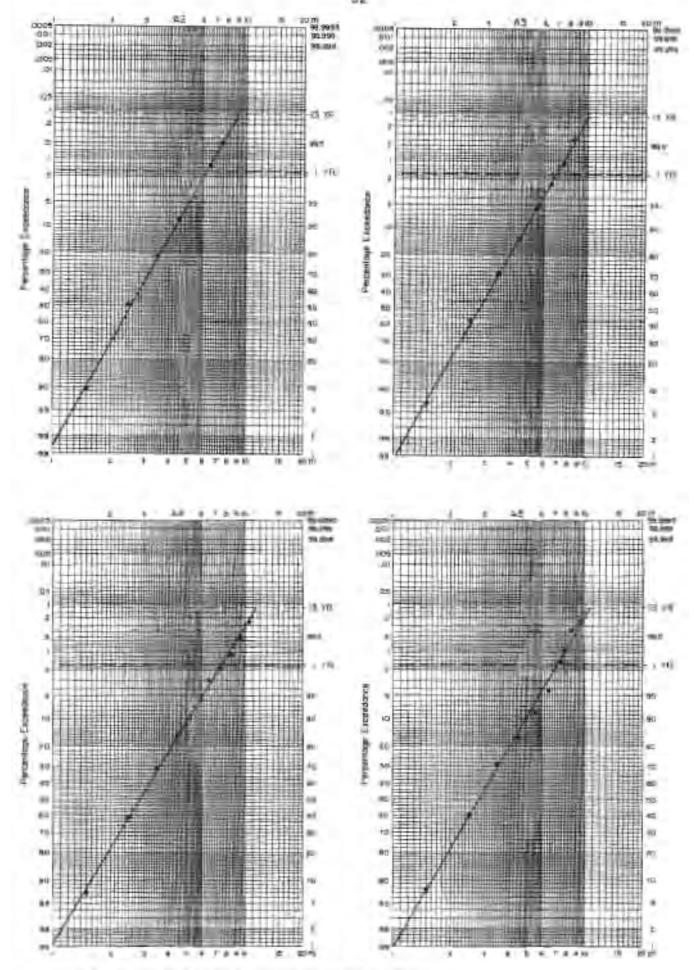


Figure 36 Monthly Wave Height Exceedance Distribution for March



Prince to Manthly Wave Height Exceedance Distribution for March

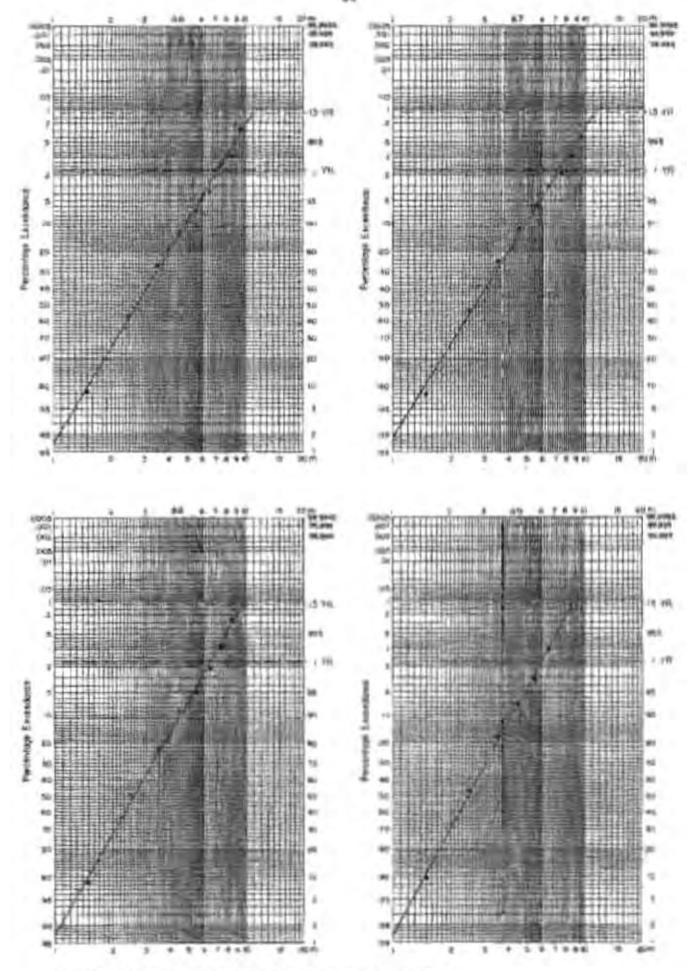


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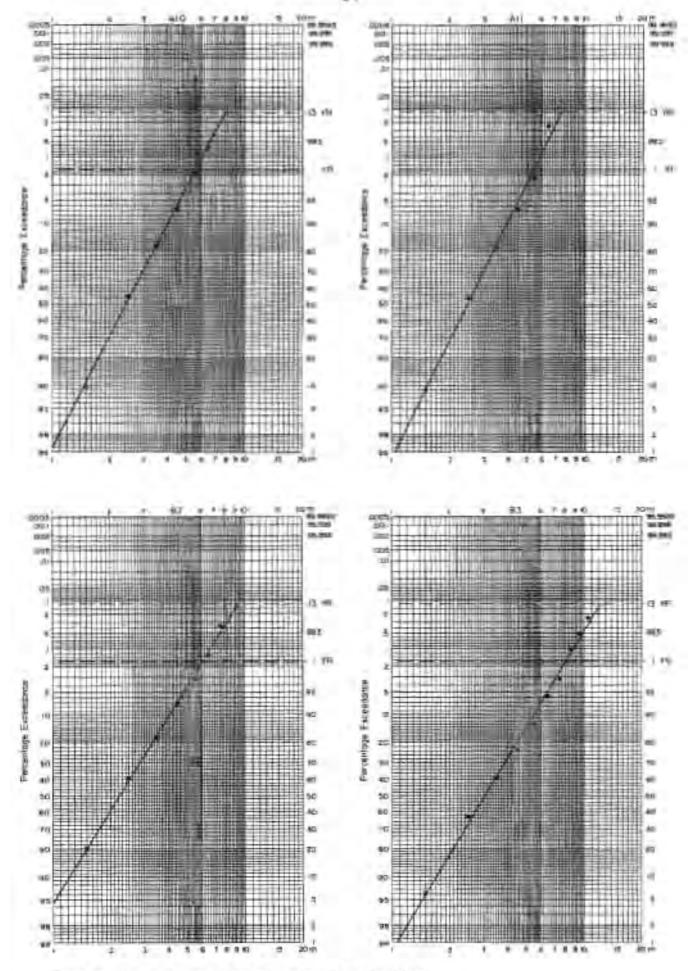
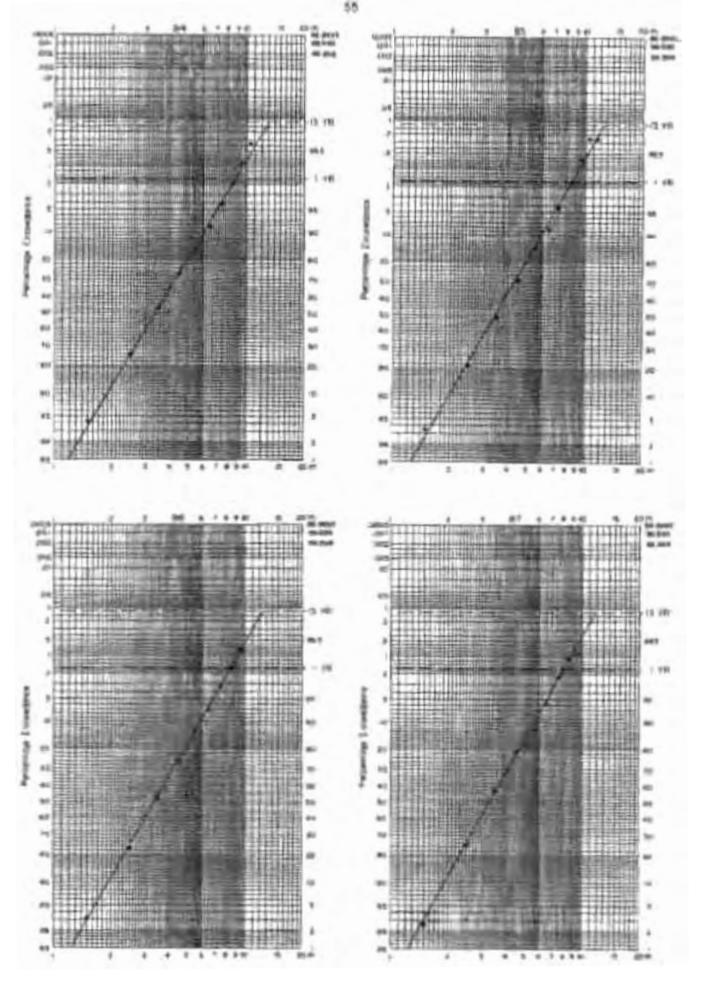


Figure 3e Monthly Wave Height Exceedance Distribution for Moreti





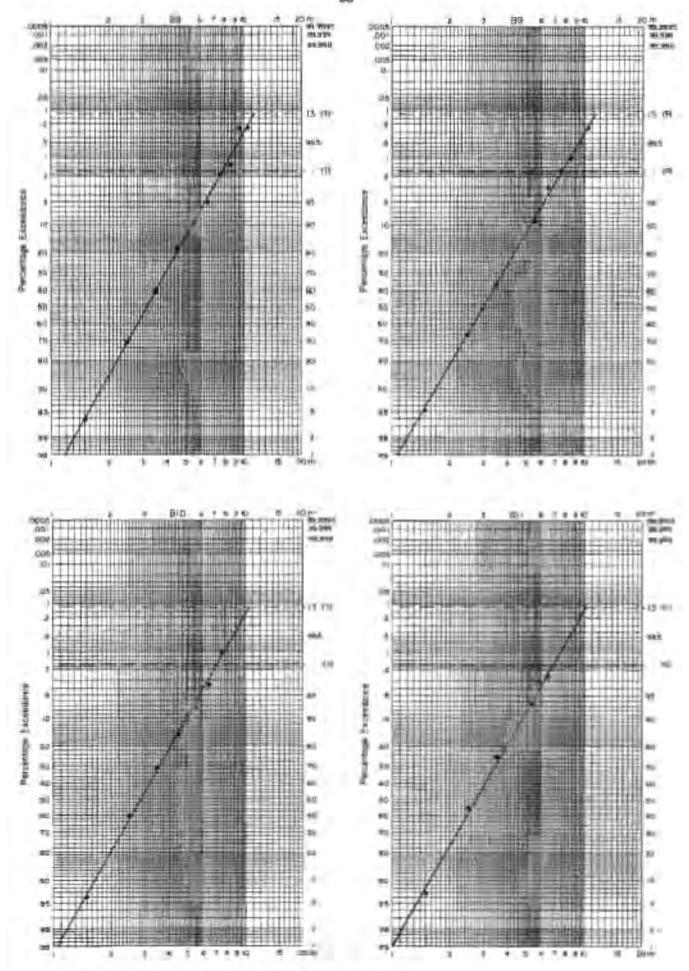


Figure 3g. Monthly Wave Height Exceleration Distribution for March

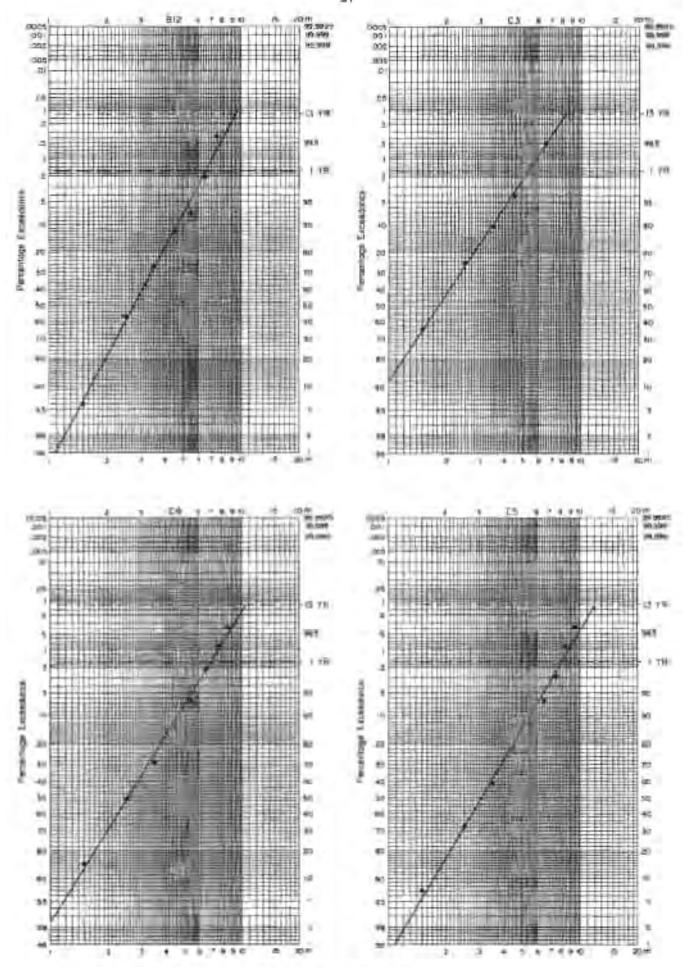
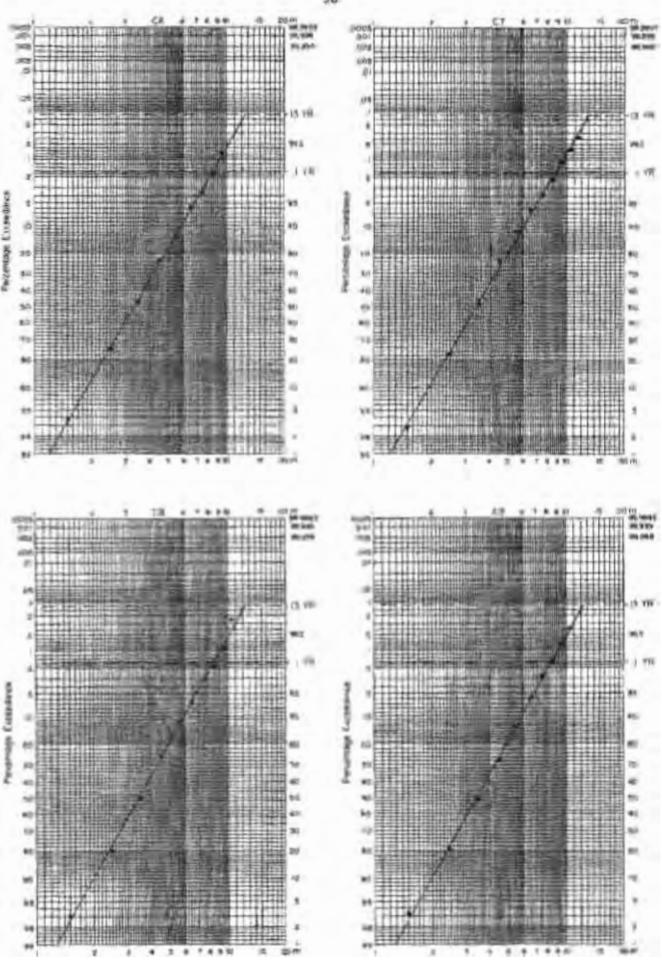
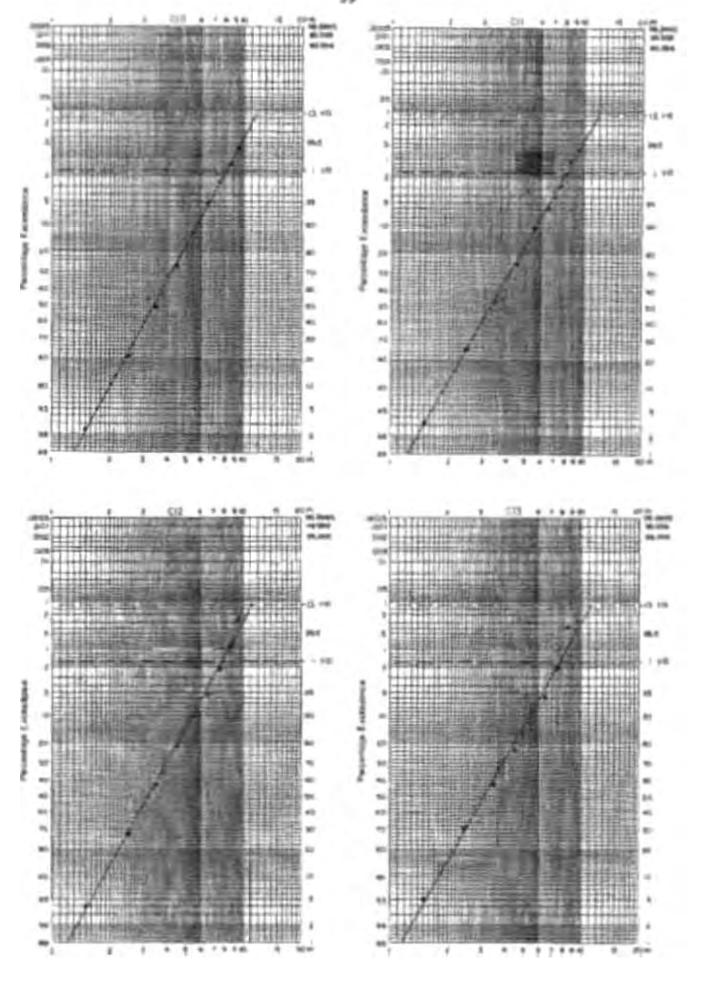


Figure St. Monthly Wave Height Exceptionce Distribution for Morce.





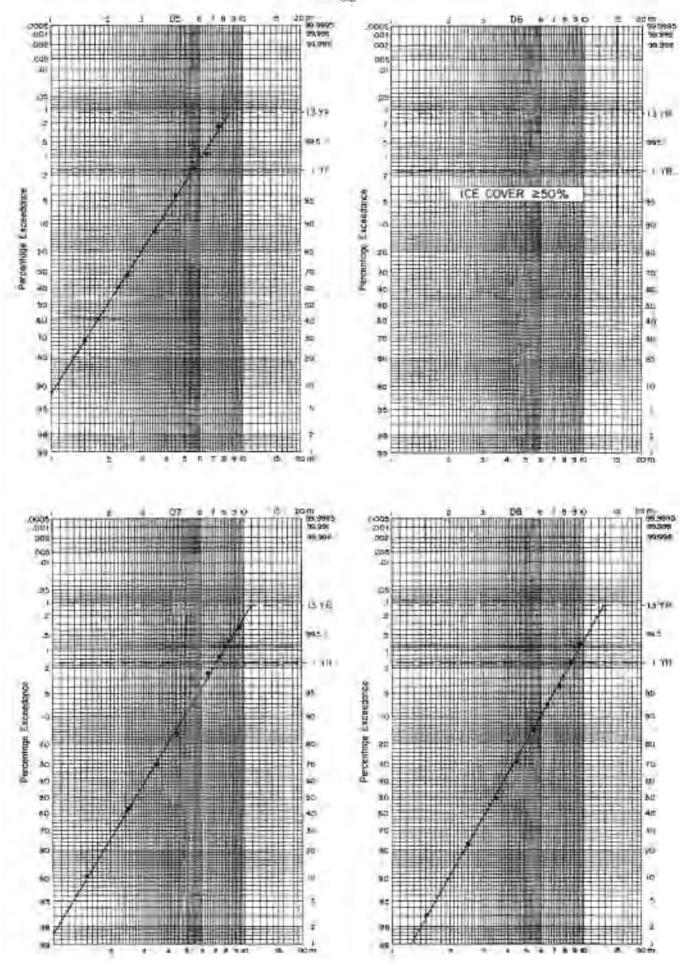


Figure 3x Monthly Wave Height Exceedance Distribution for March

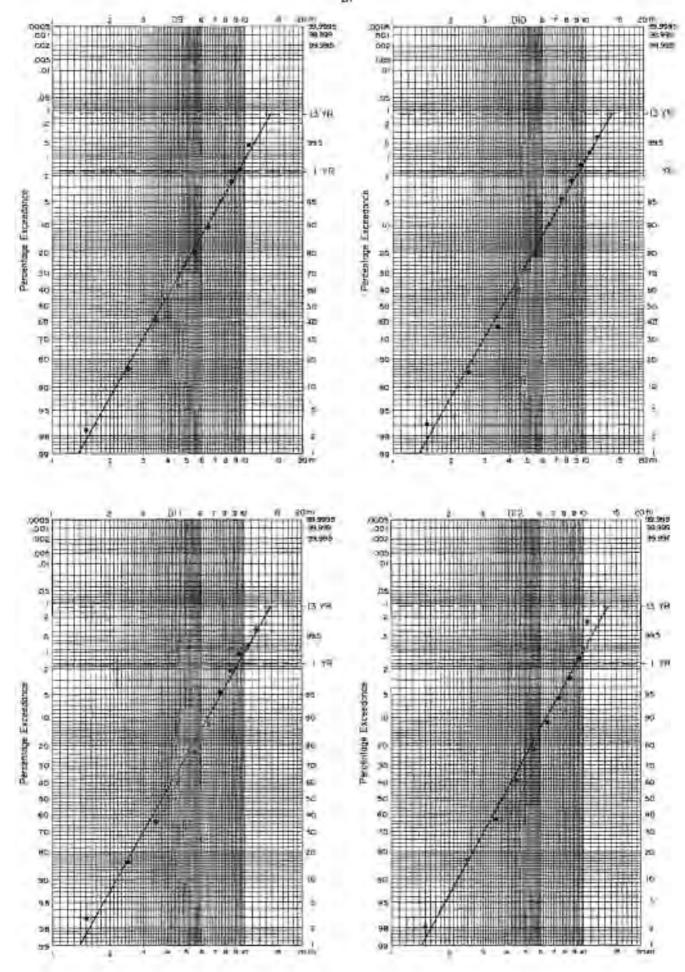
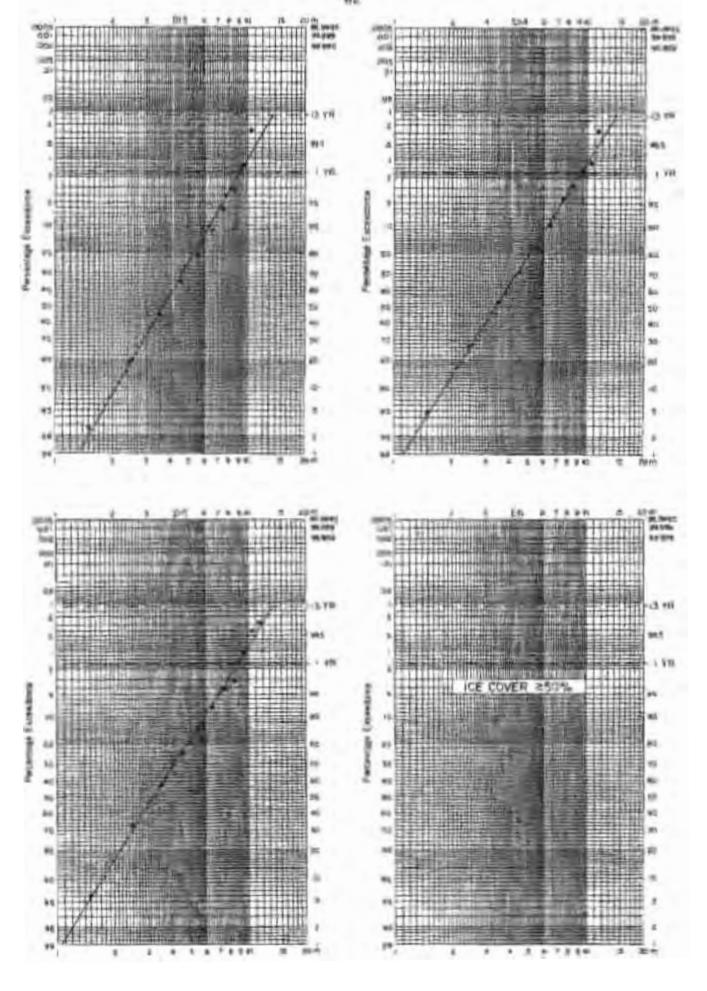
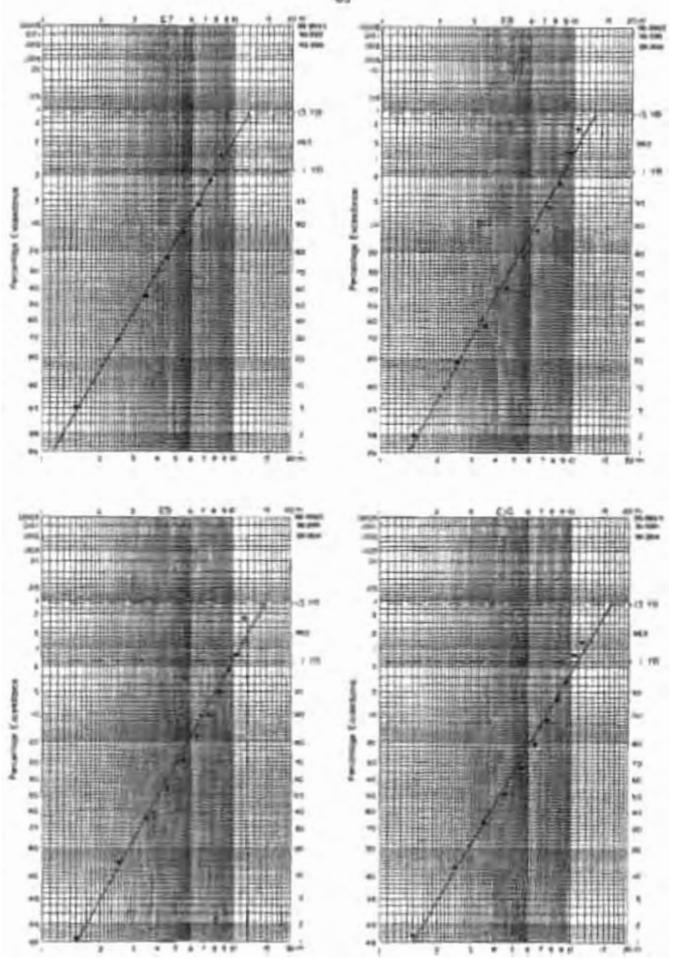


Figure 31 Monthly Wave Height Excendence Distribution for March





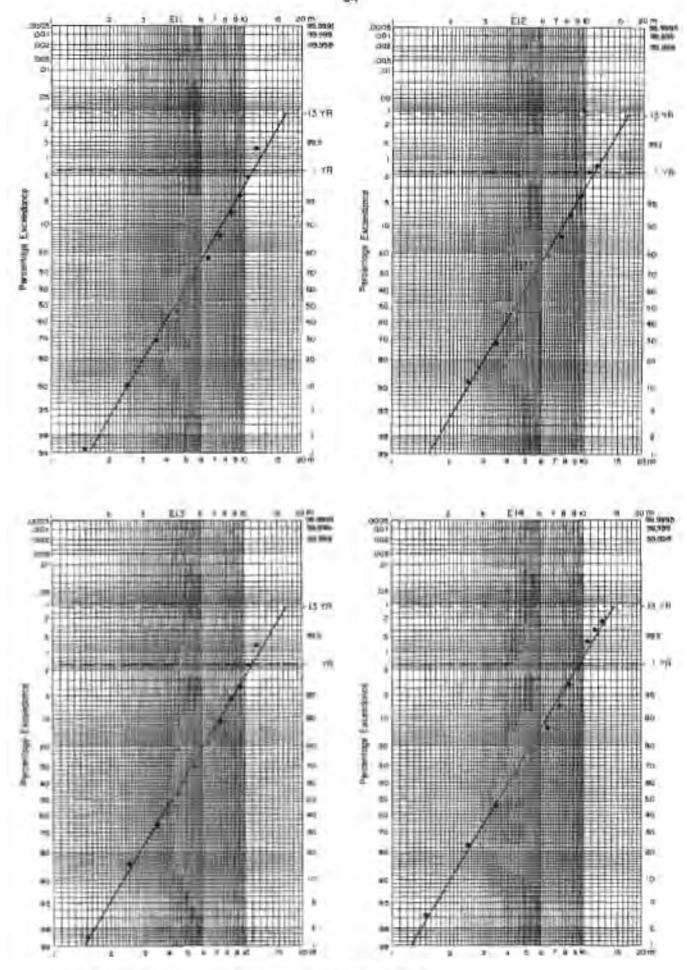


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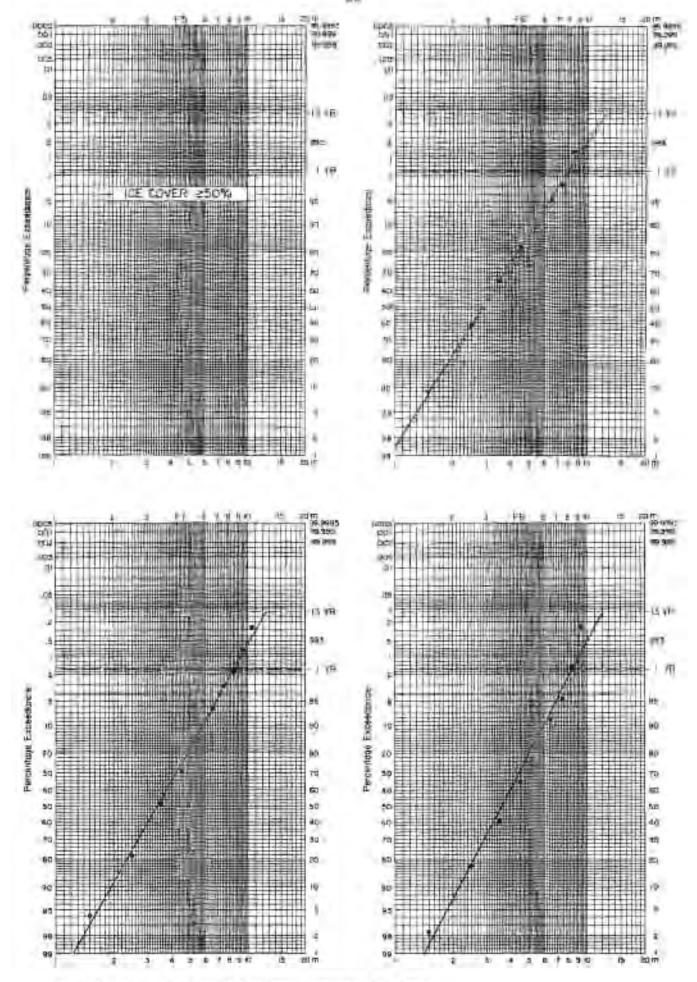


Figure 3p. Morthly Wave Height Exceedance Distribution for Moron

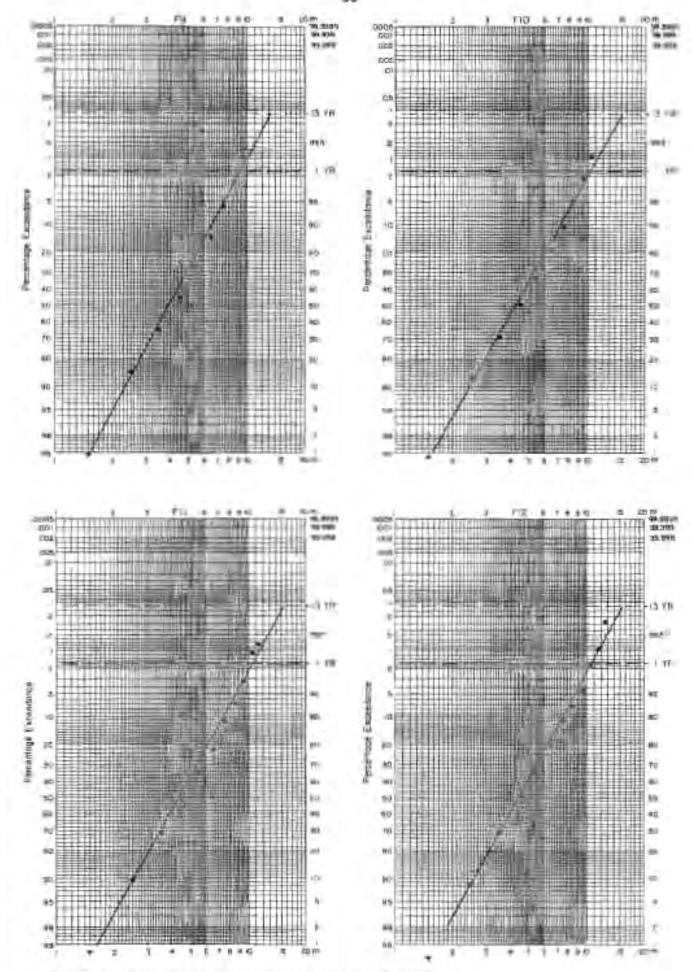


Figure 5q. Monthly Wave Height Exceedance Distribution for March

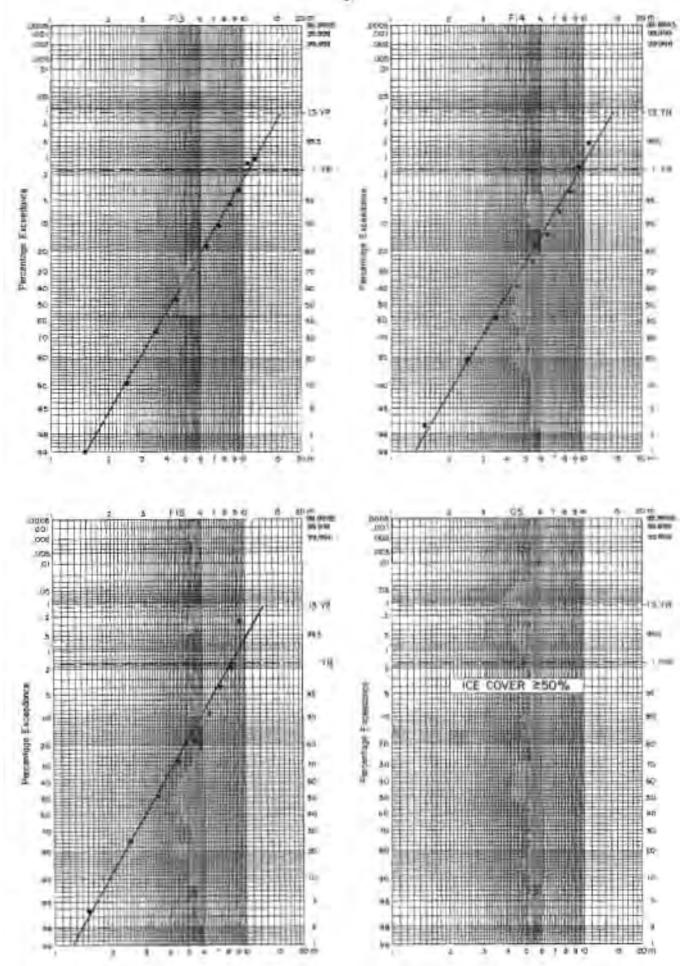
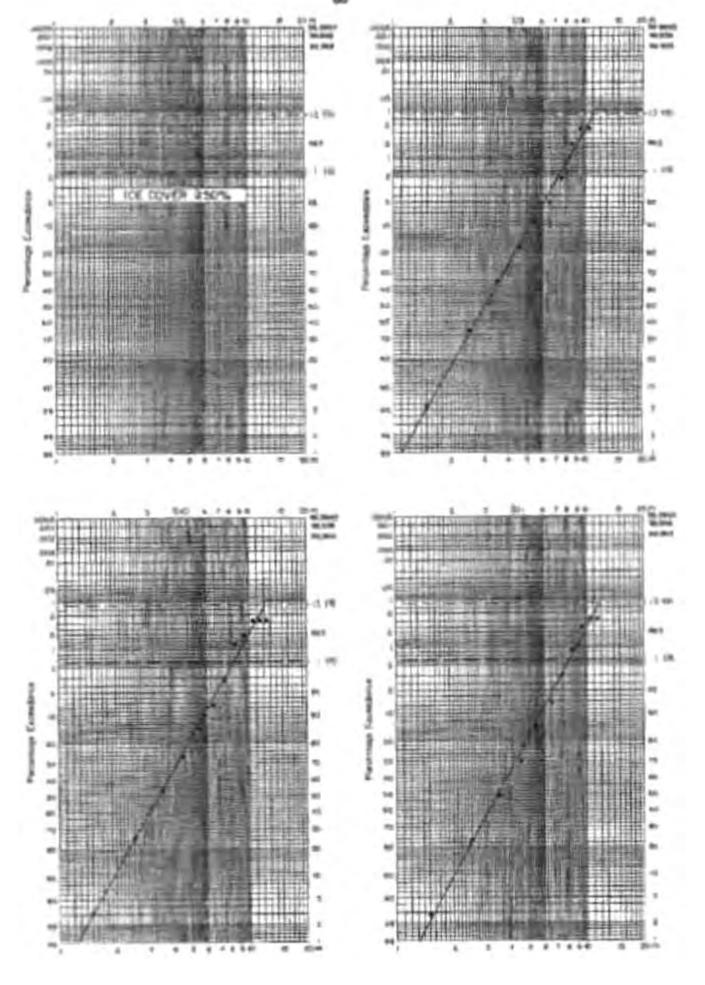


Figure 31 Monthly World Image! Exceedance Distribution for Month



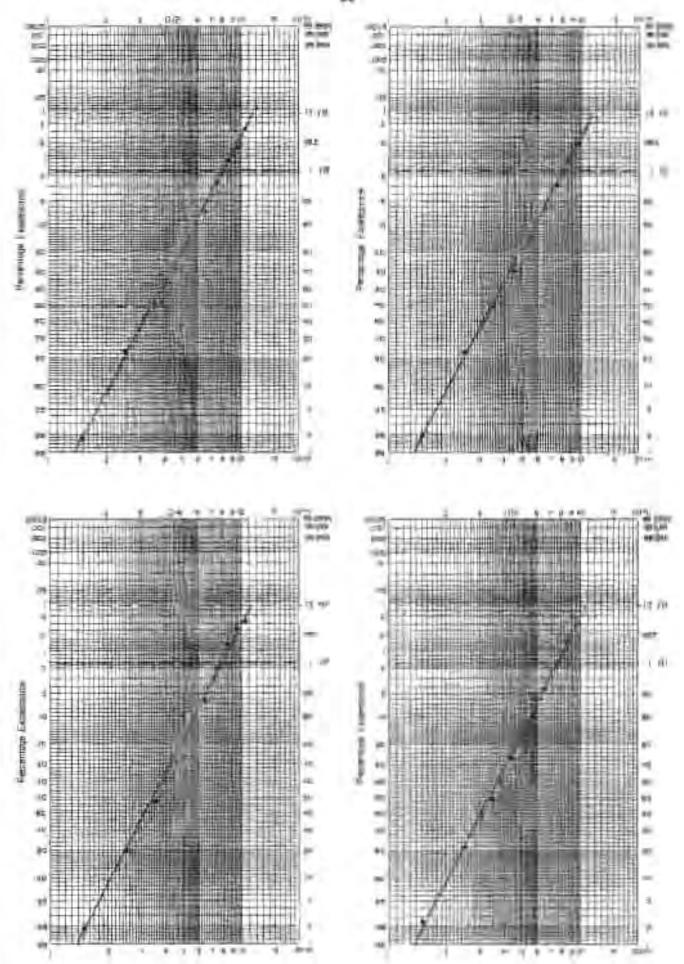


Figure 31: Monthly Whose Hought Exceptions: Drinklature for March

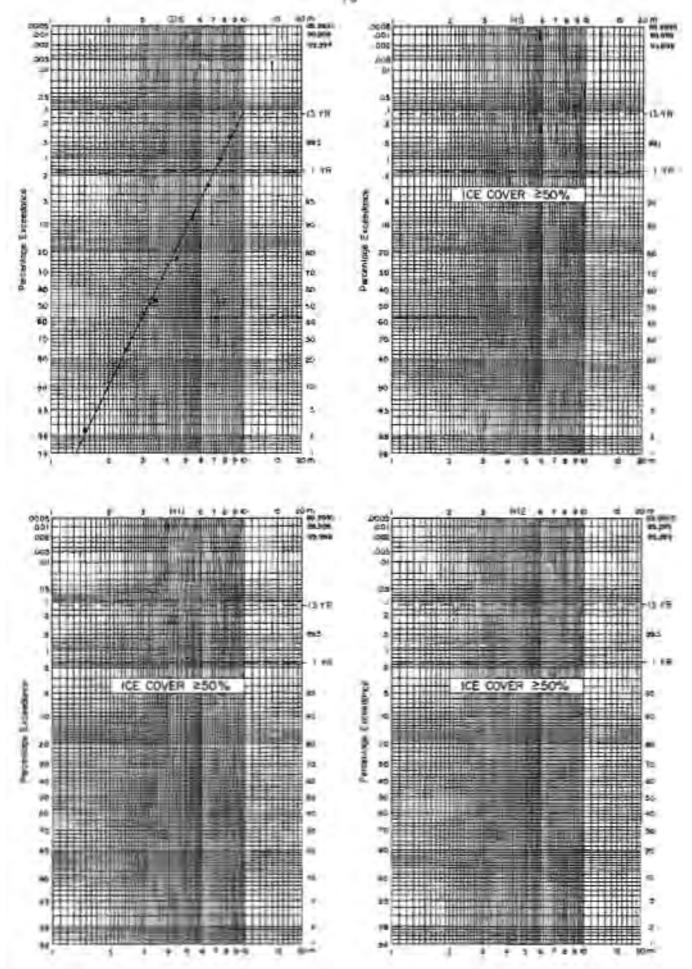


Figure 3s: Monthly Wave Height Excessionice Distribution for Merch.

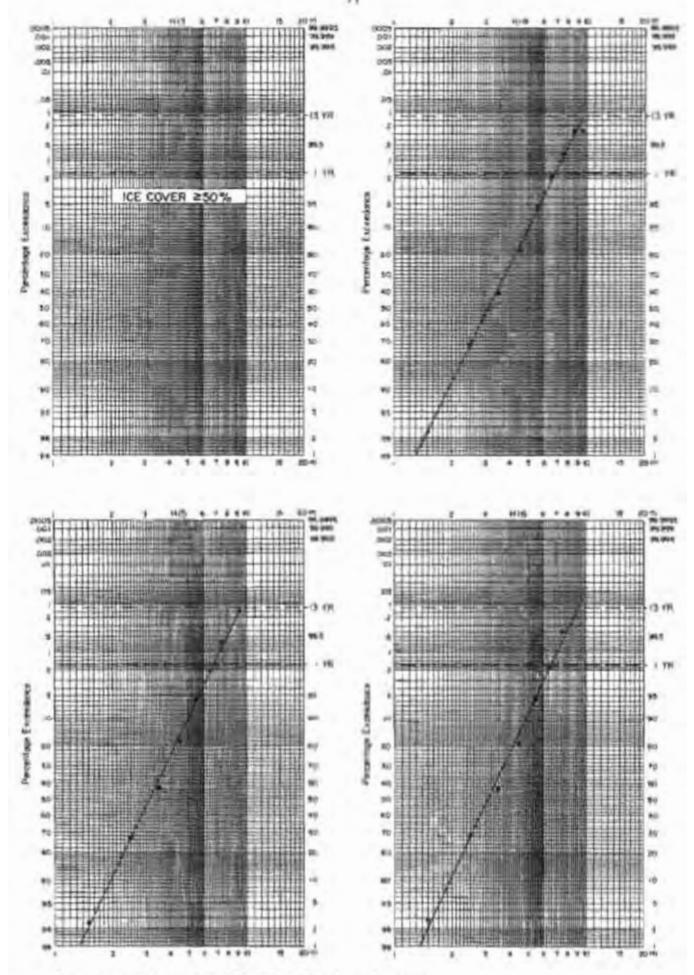


Figure 3s Monthly Wors veryte Excentions Entribution for Morch

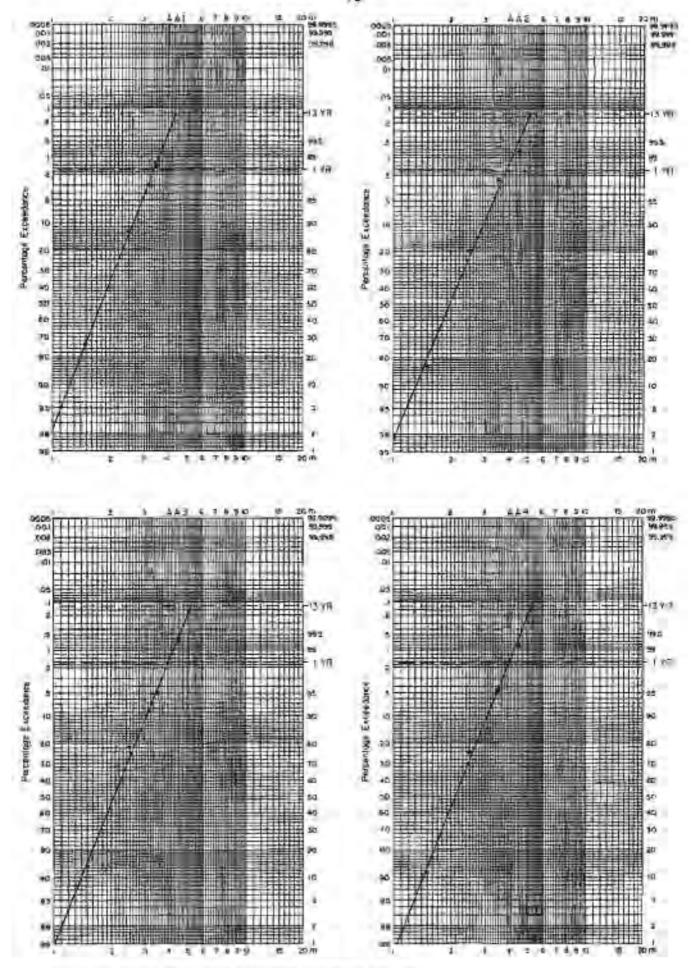
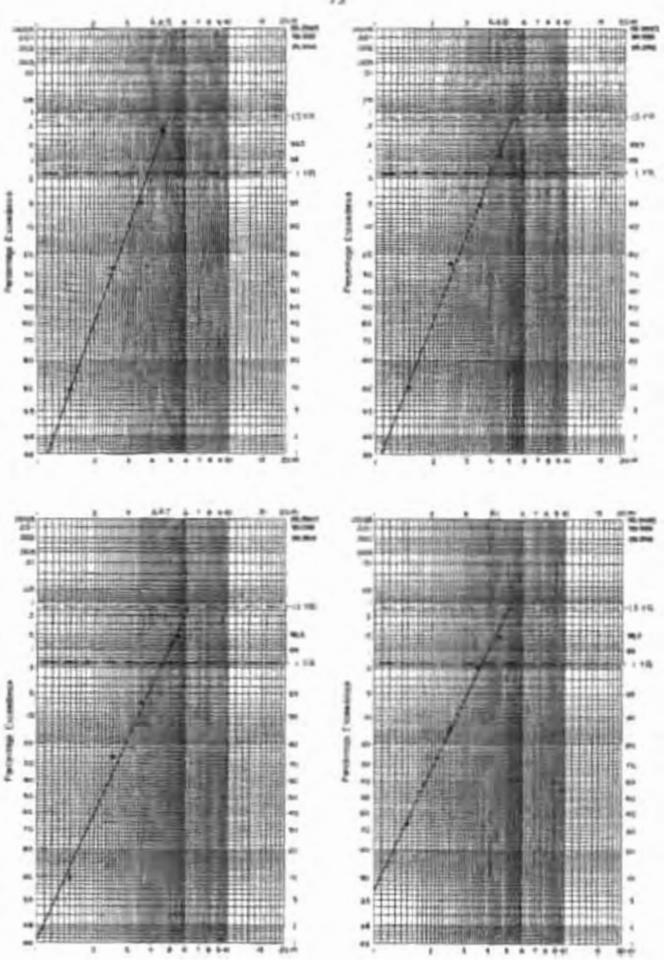


Figure 4a: Monthly Wave Height Exceedance Distribution for April



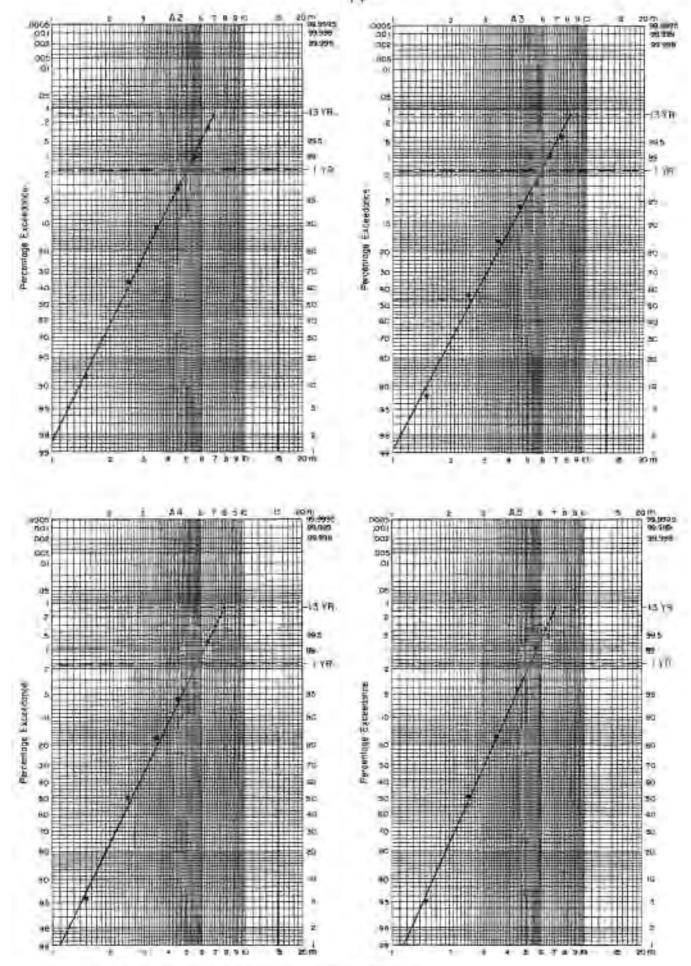


Figure 4s. Monthly Wave Height Exceedence Distribution for April

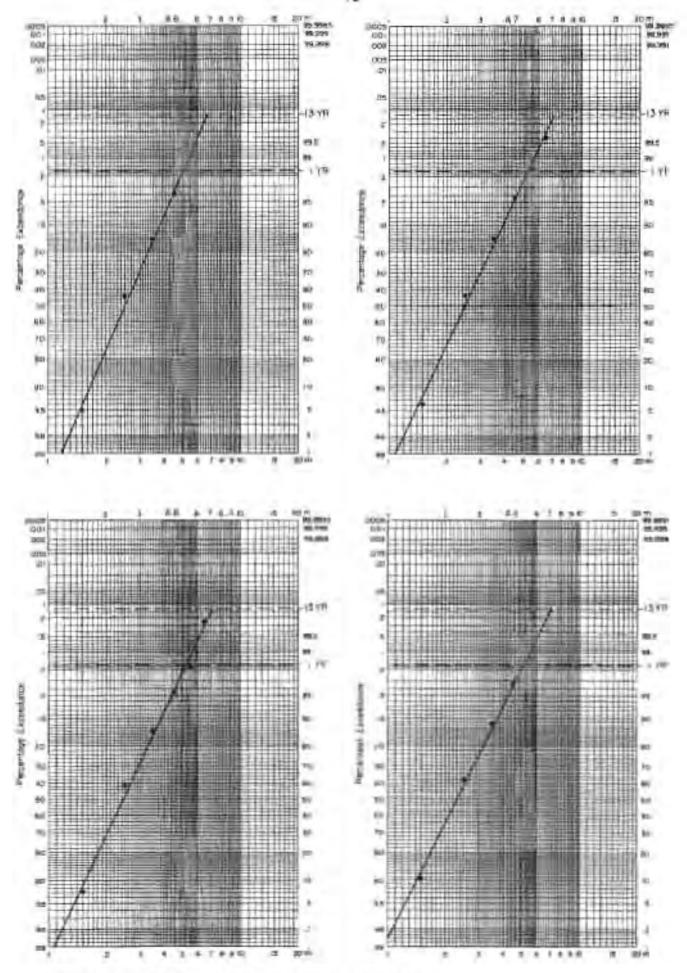


Figure 44. Monthly Wove relight Exchequines Distribution for April

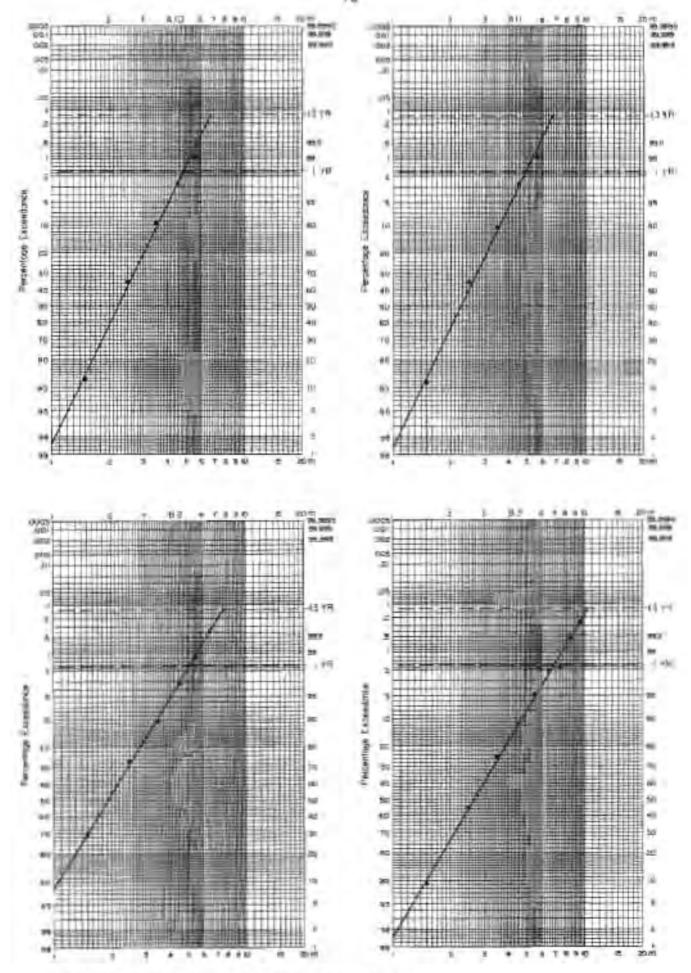


Figure the Montely Wave Height Excellational Distribution for April

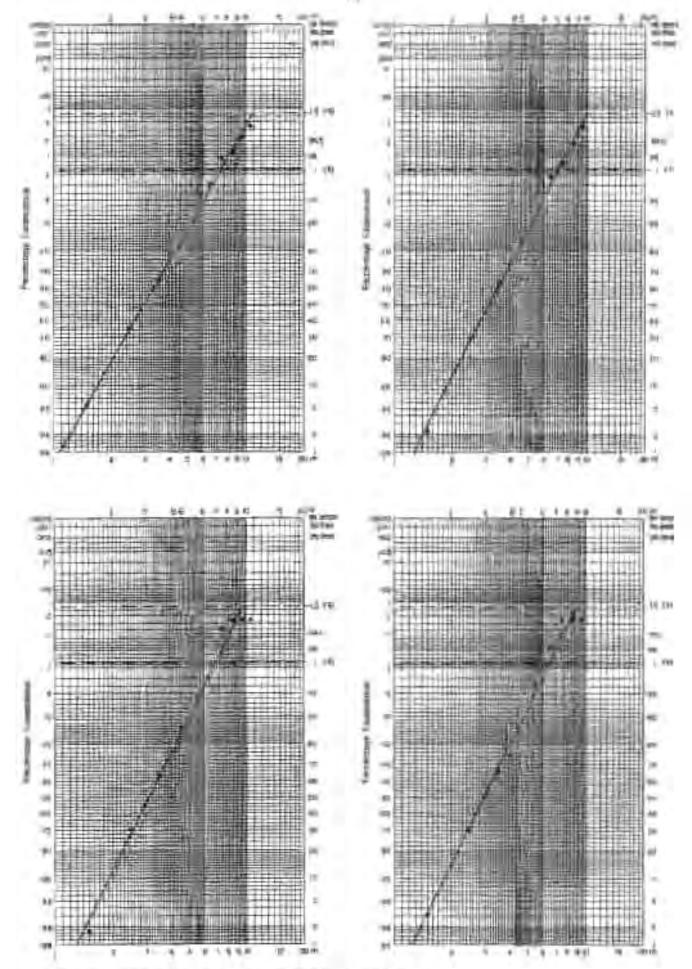
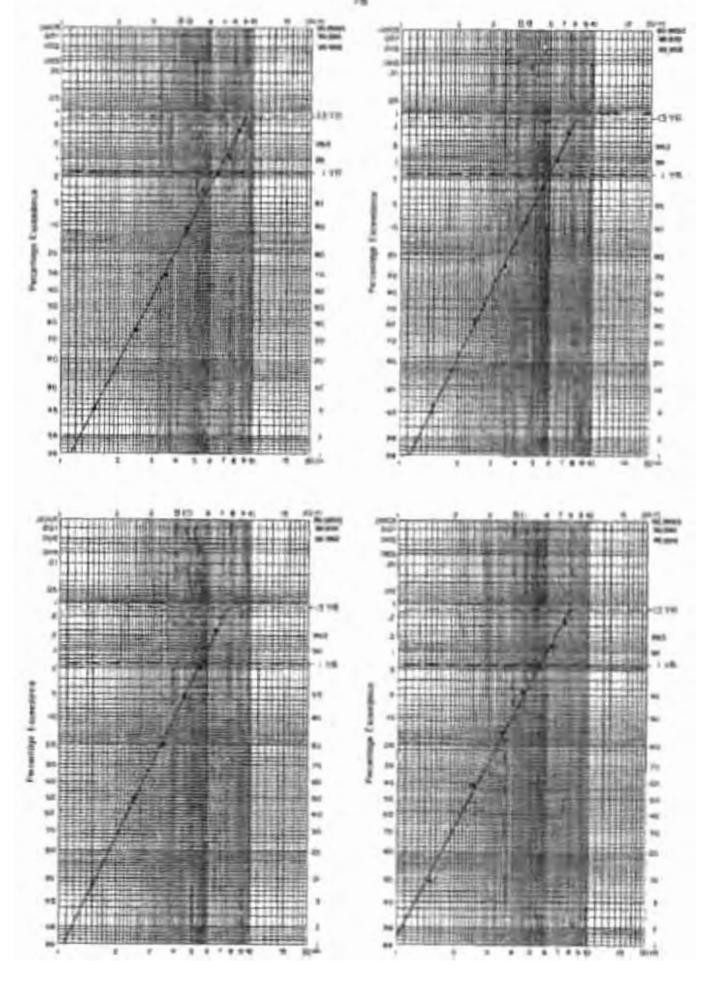


Figure 41 Monthly Witne Height Excessionor Distribution for April



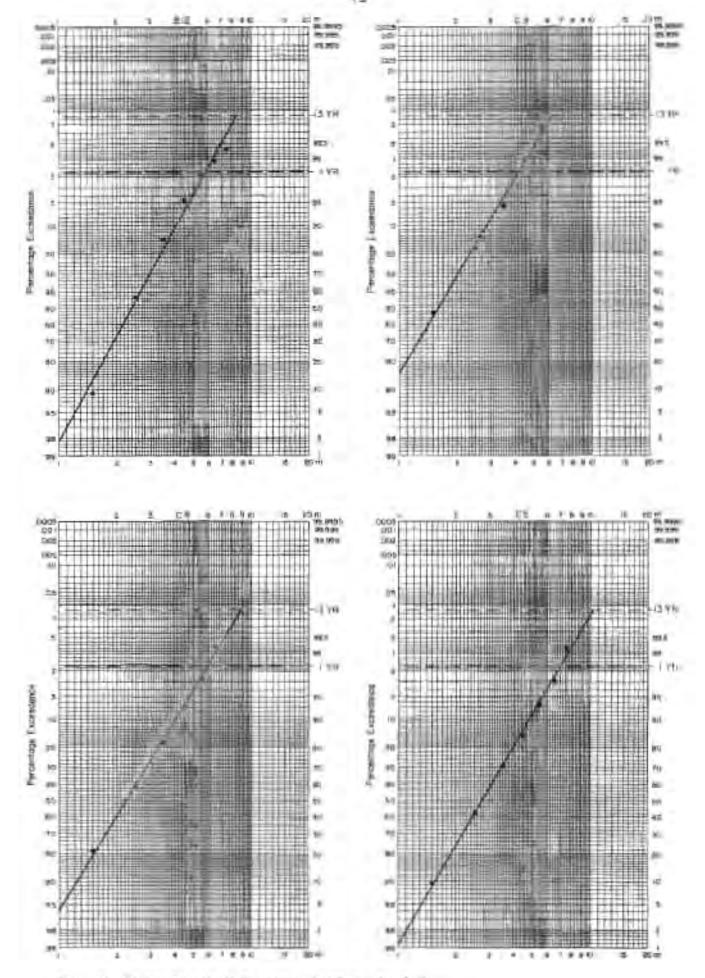


Figure 4h. Months Wove Height Exceptionis Distribution for April

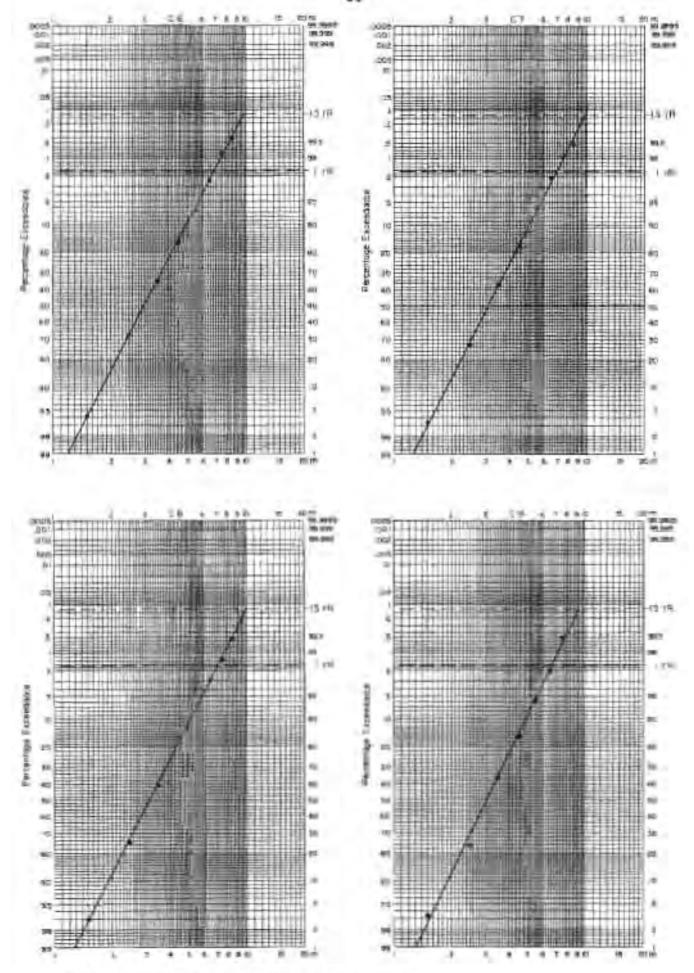


Figure 41 Months Wave Height Exceptionice Distribution for April

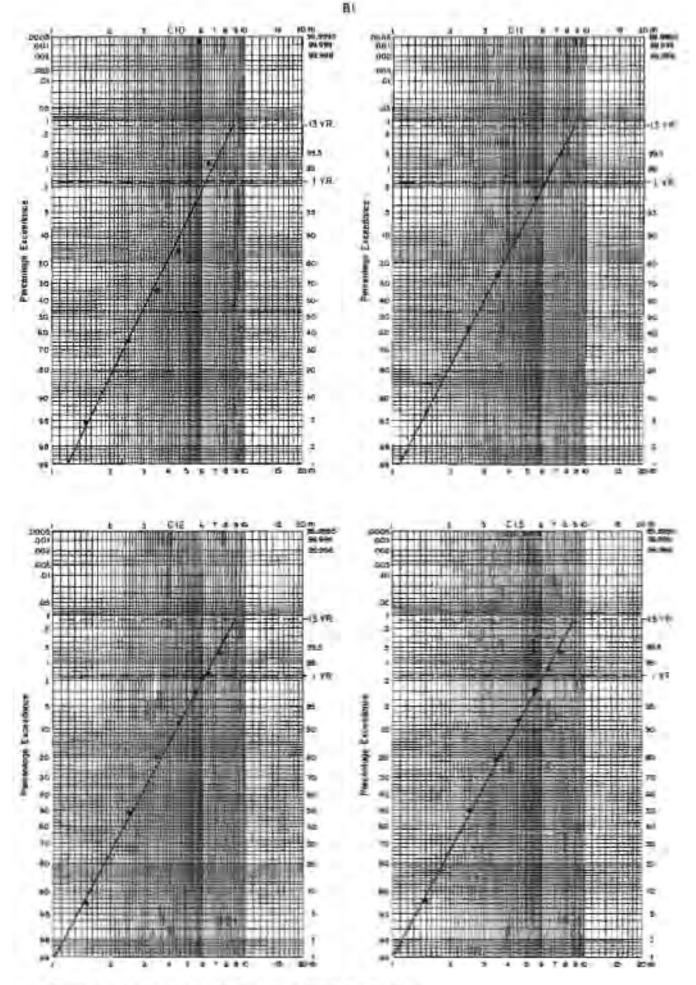


Figure 4). Monthly worse traight Excendence Contribution for light

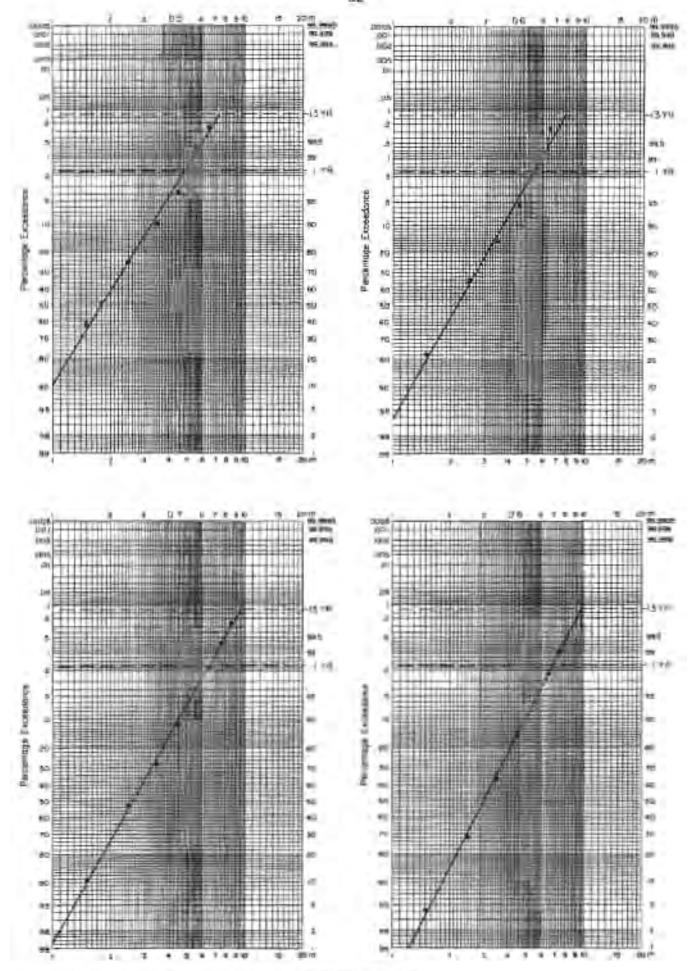


Figure #4: Monthly Wave Height Exceedance Distribution for April

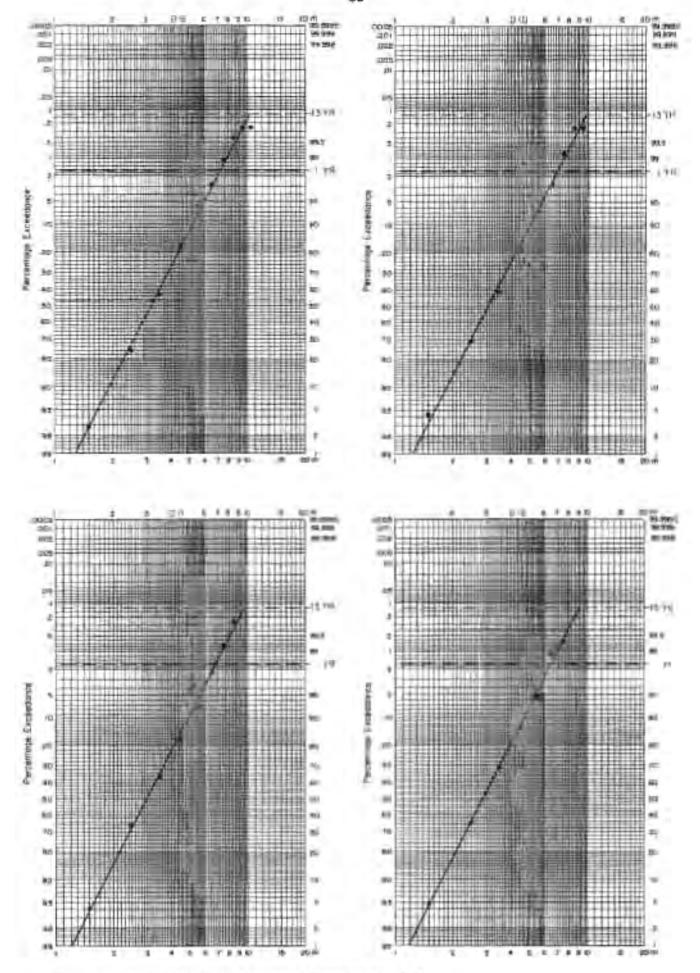


Figure 41 Monthly Wave Height Exceedance Distribution for April

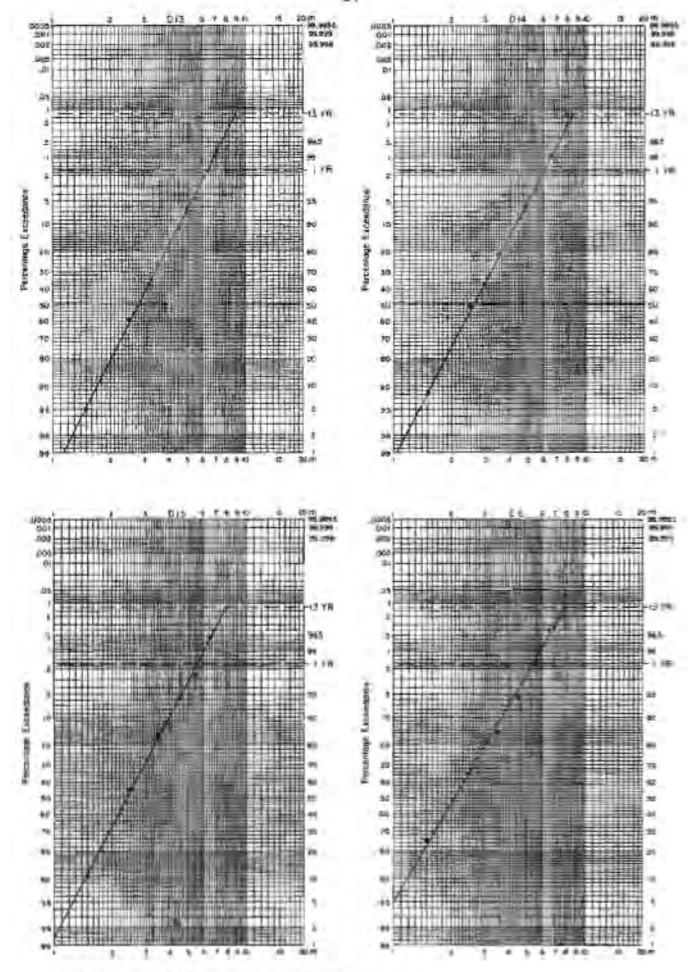


Figure 4m. Monthly Wave Hargin Extremiture Distribution for Spot

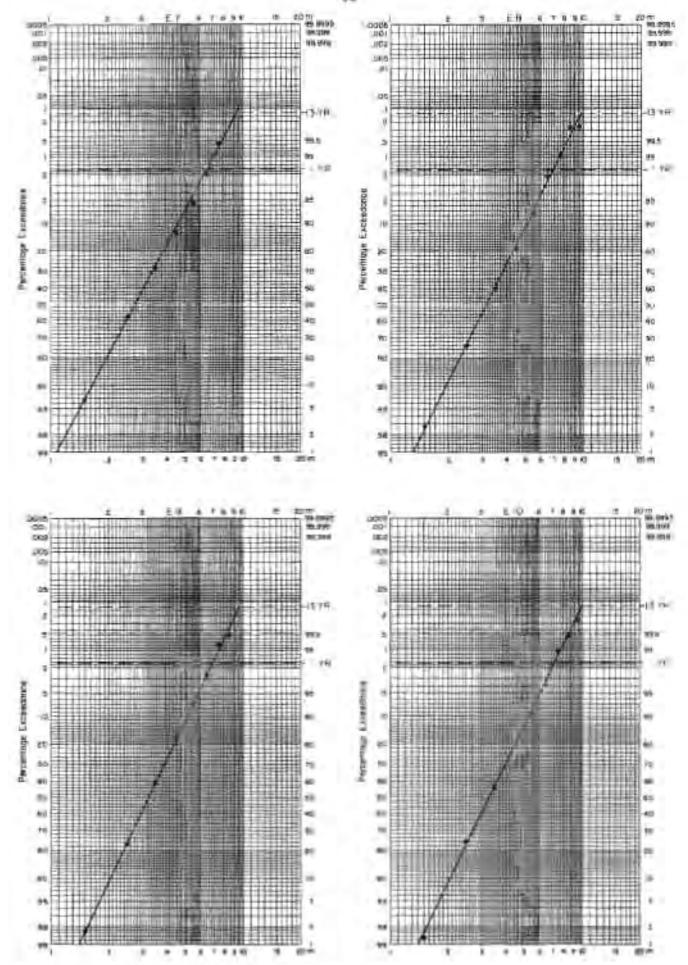


Figure 4n. Monthly Wase relight Exceedurics Distribution for April

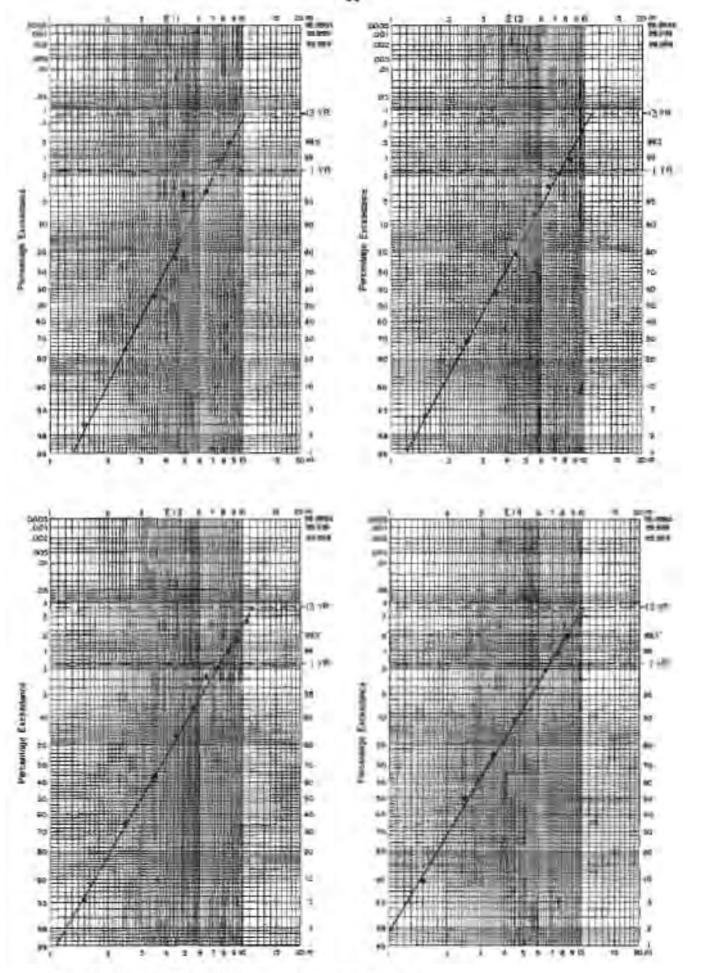


Figure Ao. Monthly Wore Height Excenditude Distribution for April

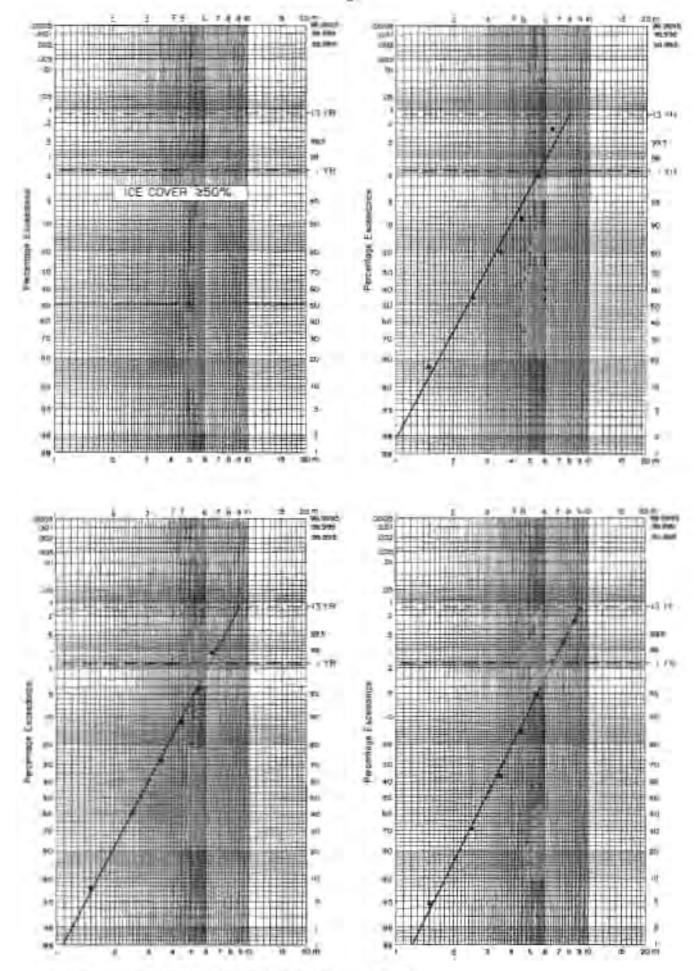


Figure 4p. Monthly Wave Height Exceedance Distribution for April

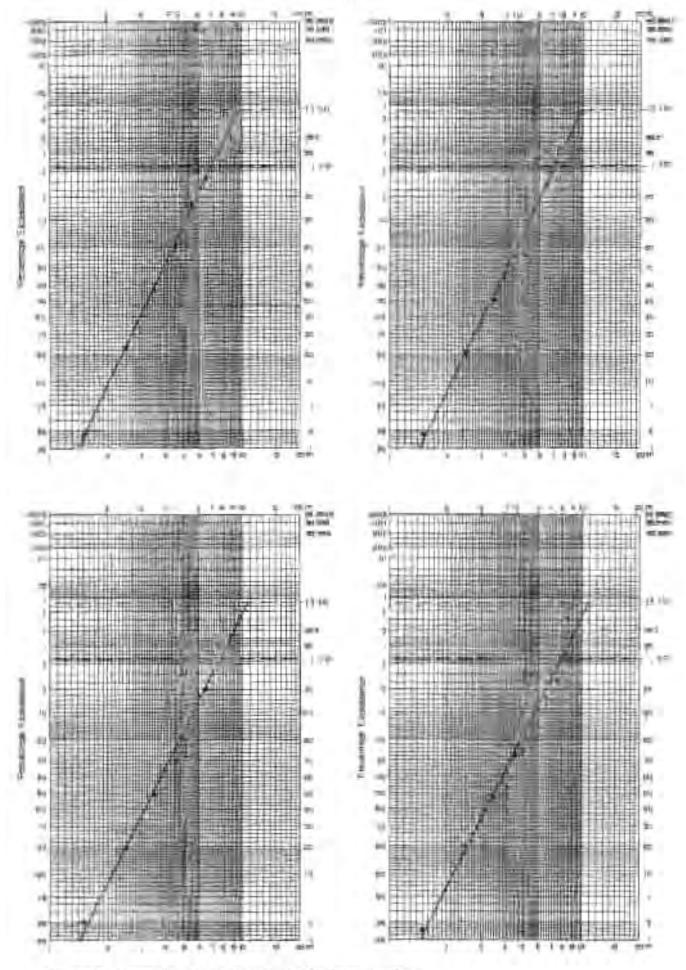


Figure 4g Marking Work Fleight Excessionics Distribution for April

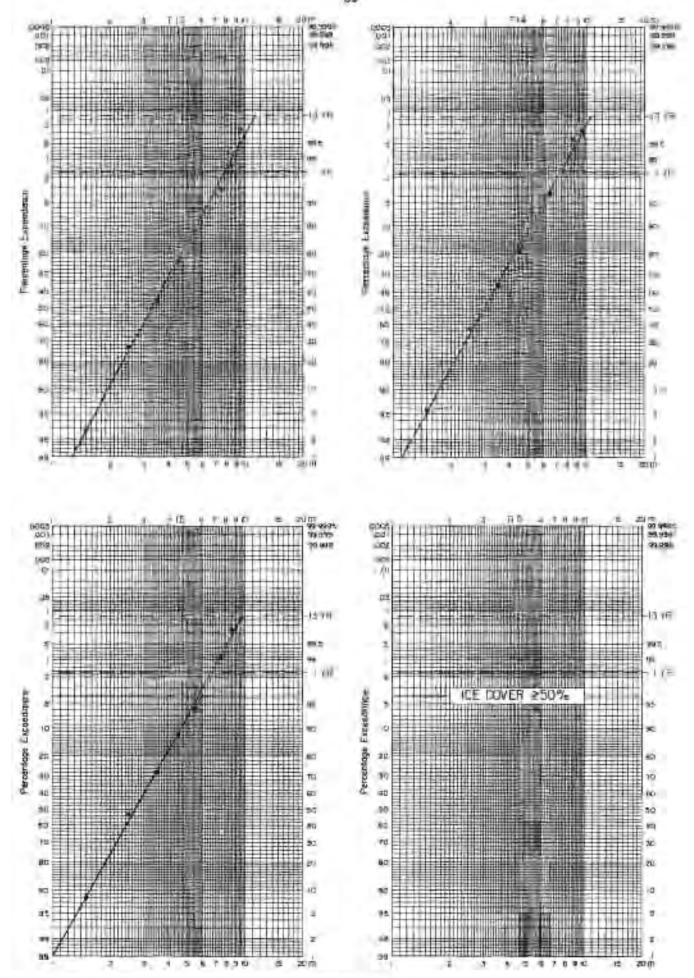


Figure 4r. Monthly Wave Heigh! Exceedance Distribution for April



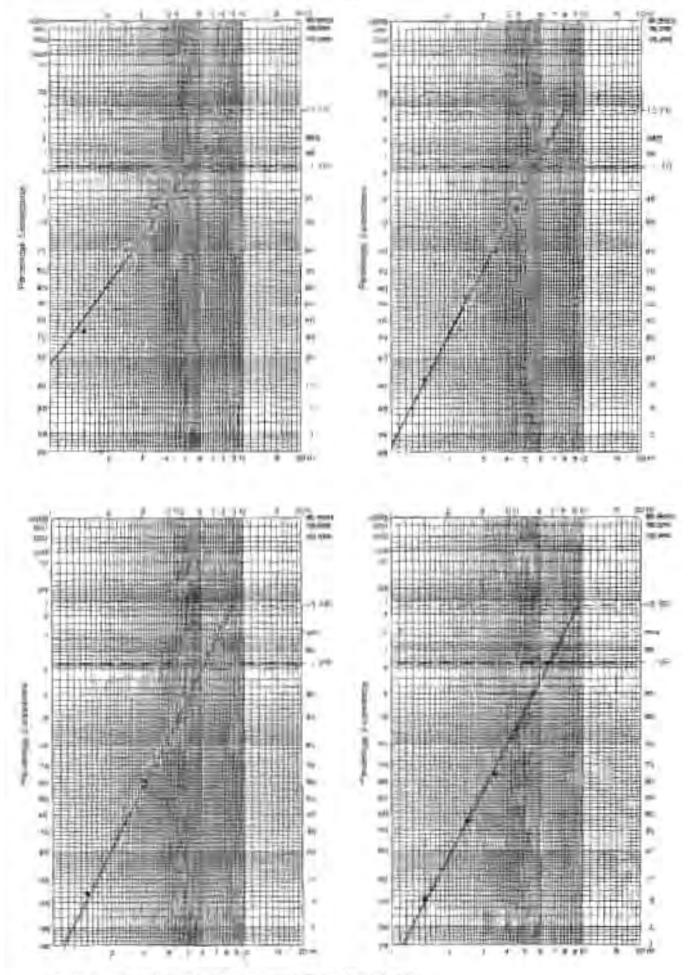


Figure its: Murray Witte Height Extransional Distriction by Agril

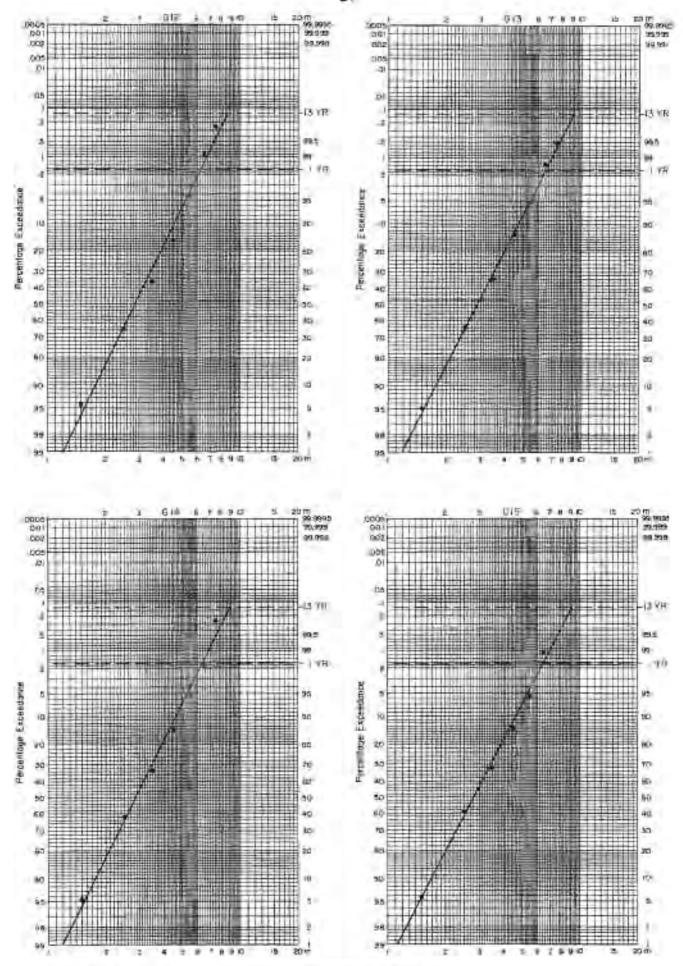


Figure 41 Monthly Wave neight Exceedance Distribution for April

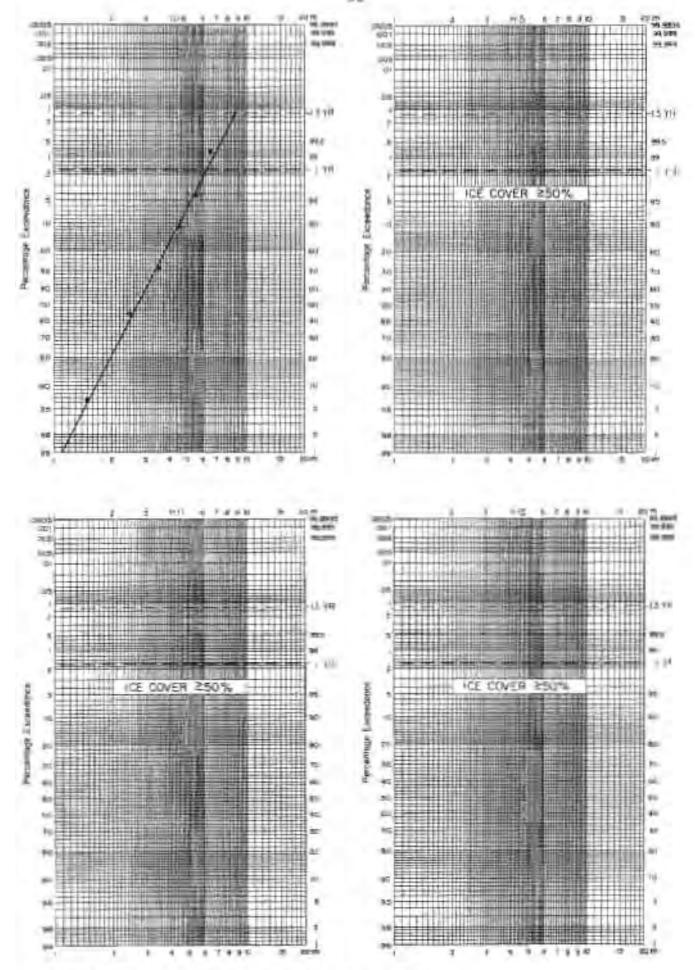


Figure 41. Monthly Work Height Exceedance Distribution for April

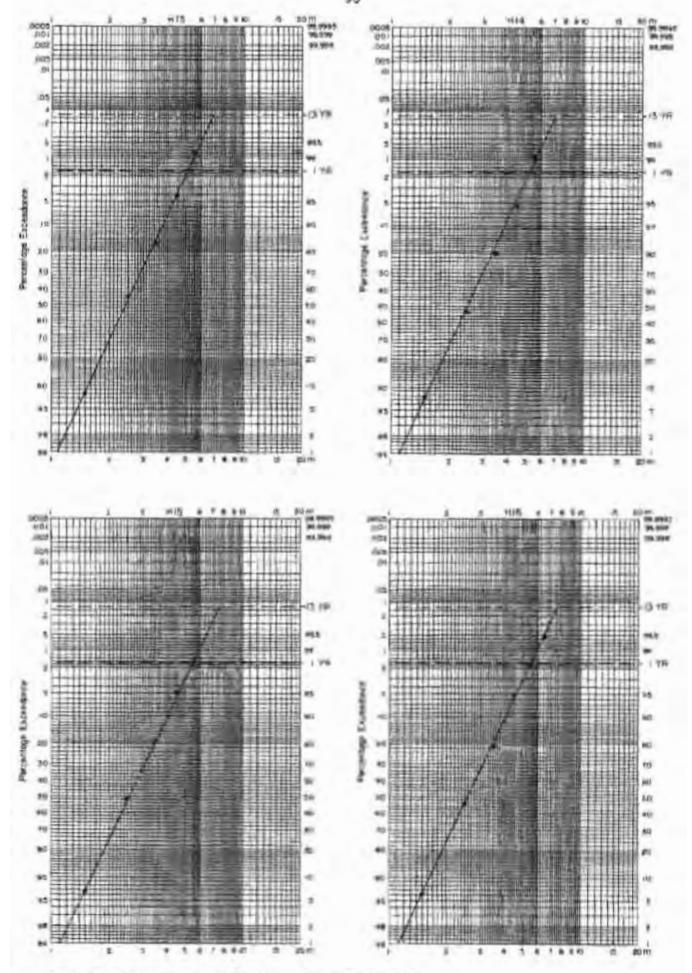


Figure its. Monthly Wave Height Excessorics Costribution for April

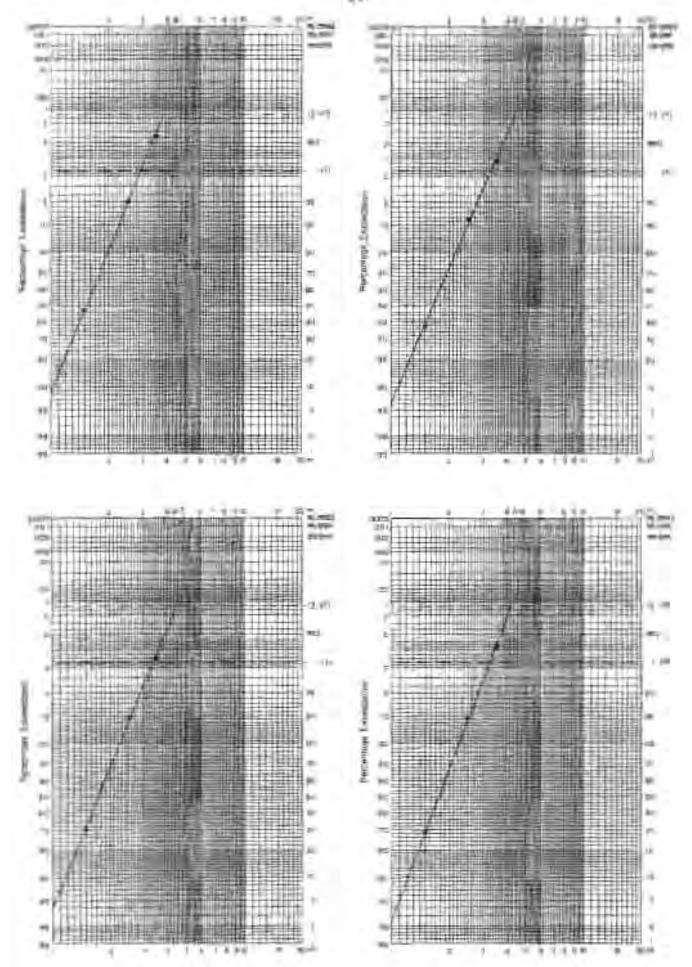


Figure try: Majornia Major Height Exceedings Distribution for Major

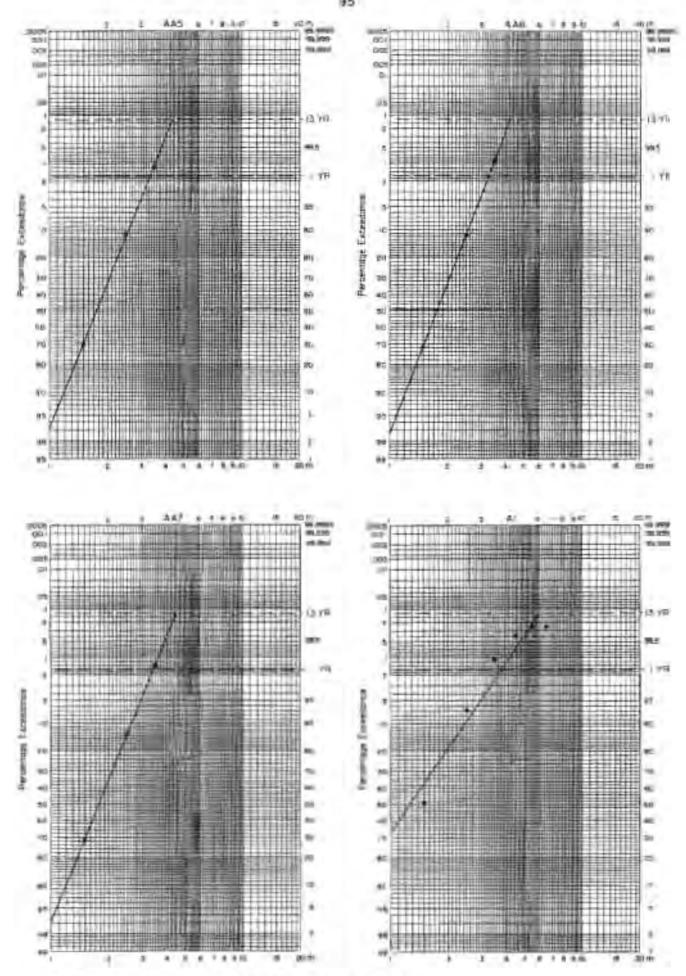
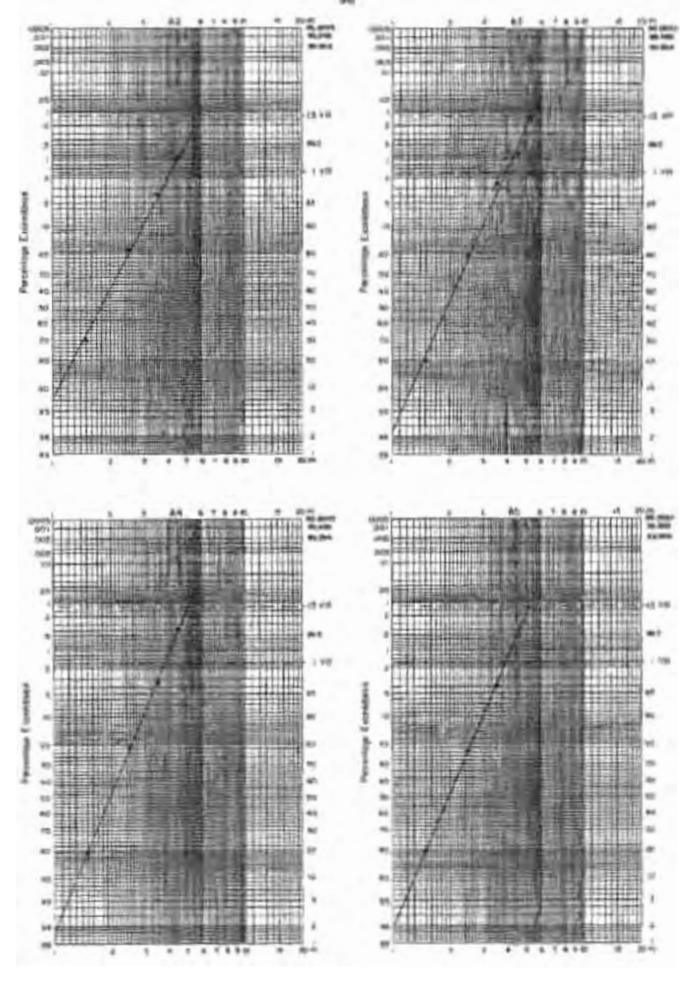


Figure Sc. Monthly Wave Height Exceedance Distribution for Mon



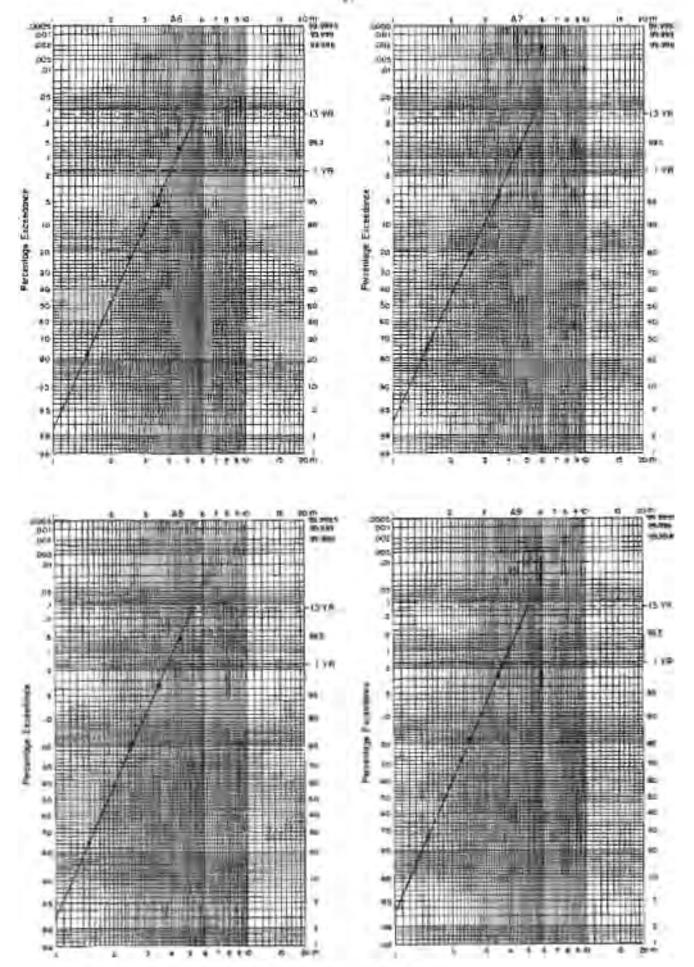
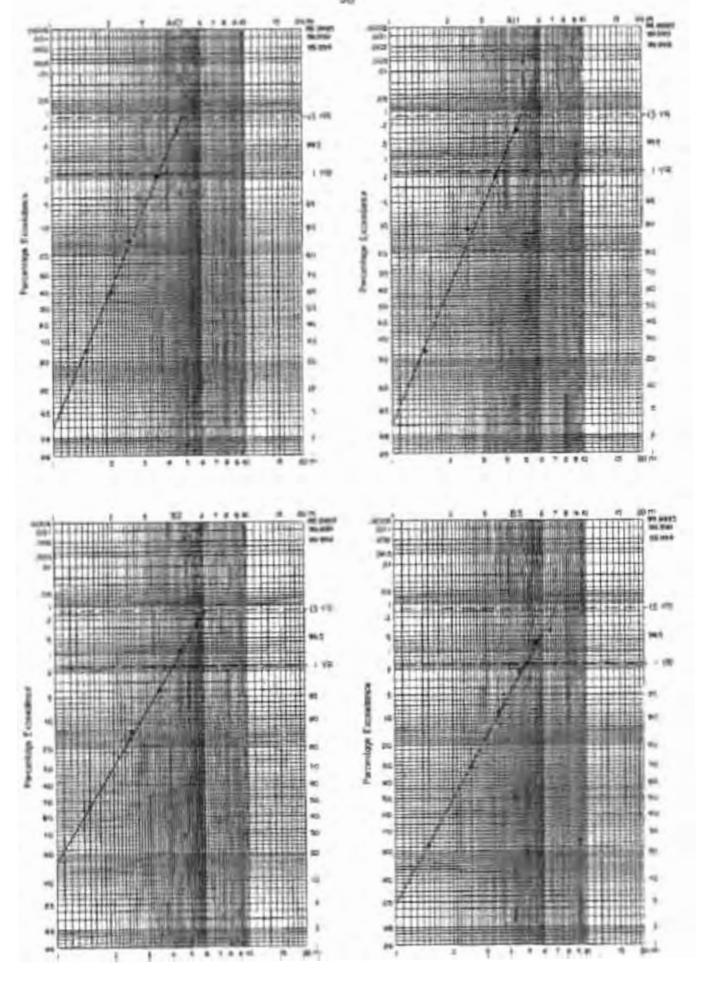
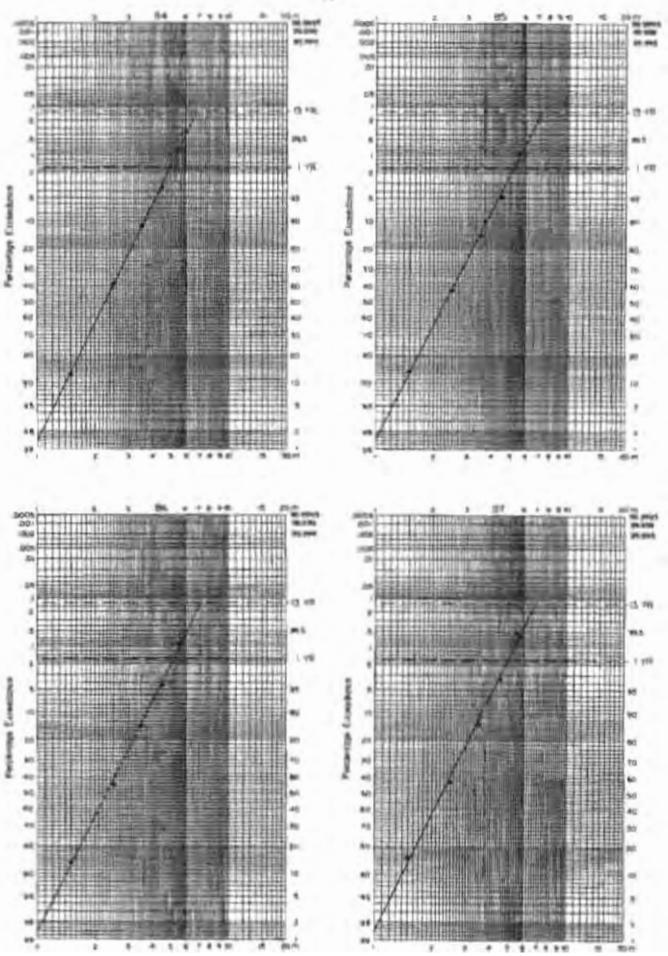
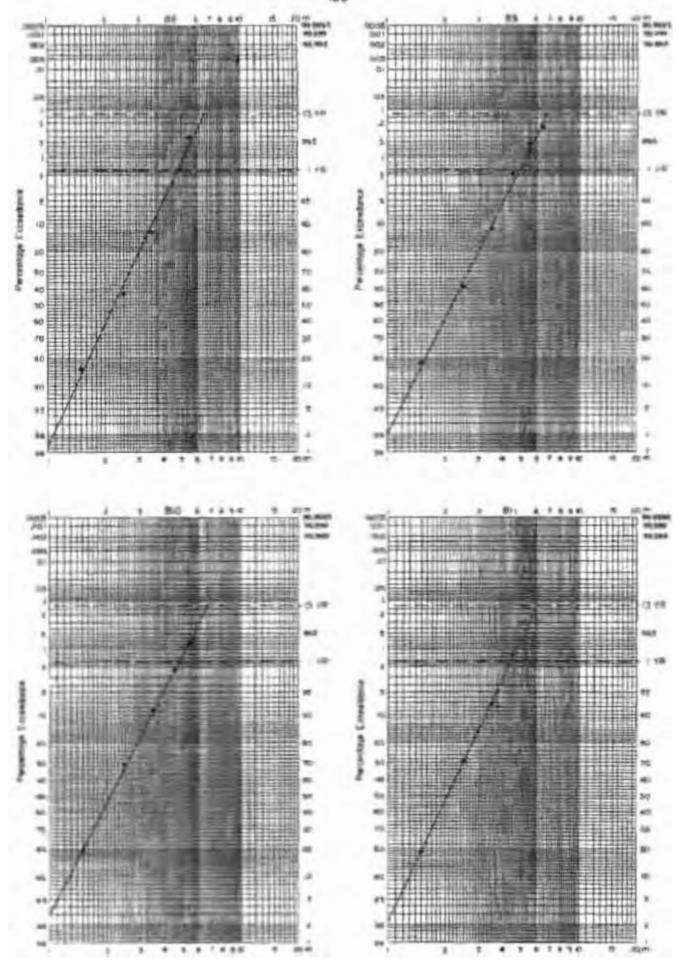


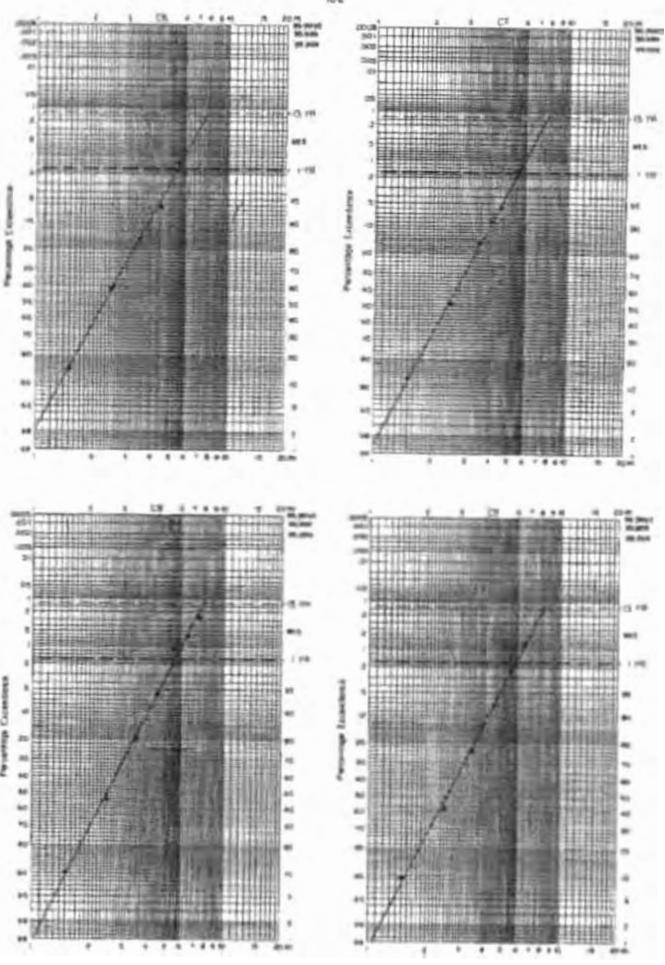
Figure Sul. Microriy Royal Faught Exceedonol Diandburner for May











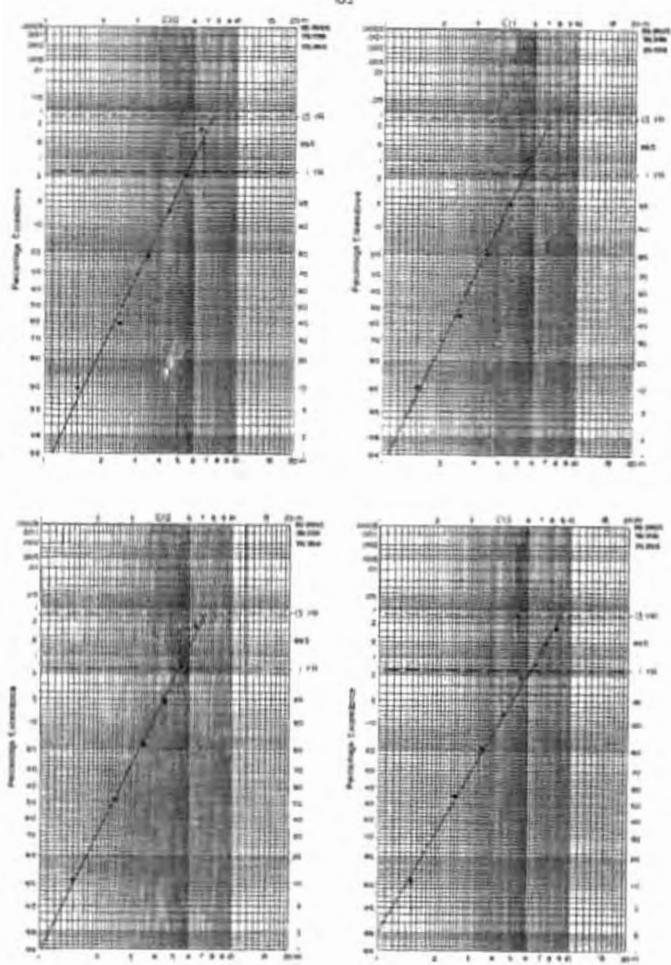


Figure 51. Monthly Wave Height Exceedance Distribution for May



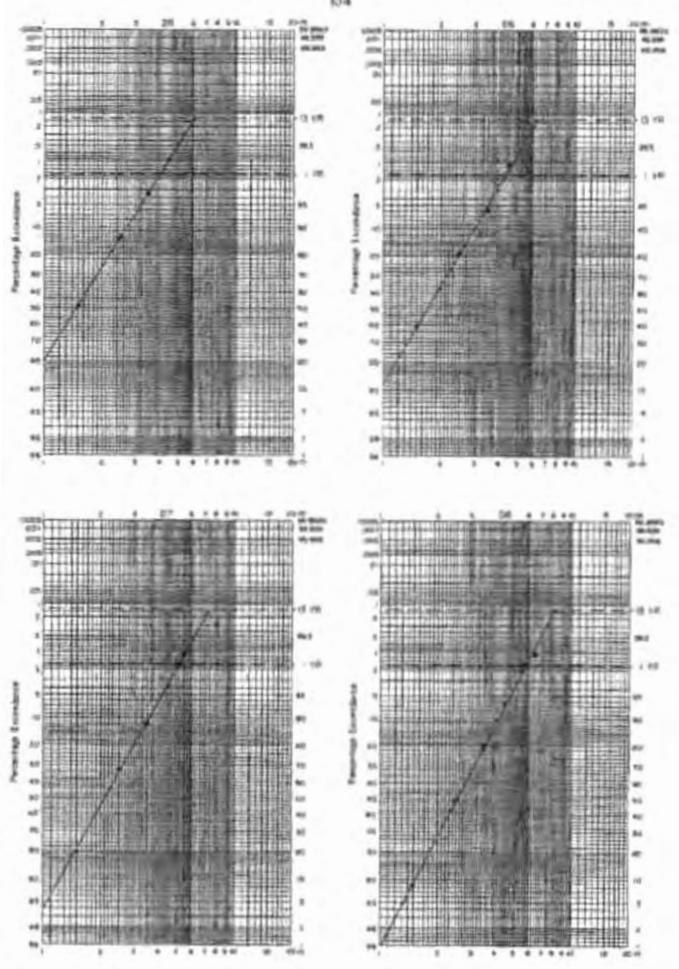
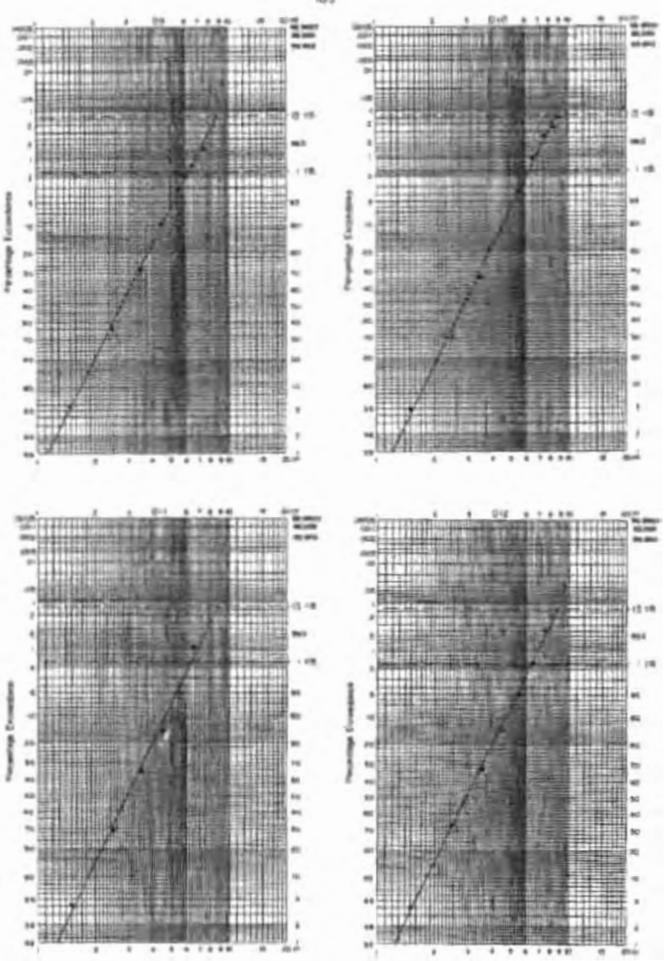


Figure to Monthly Wave People Excessions Distribution for May



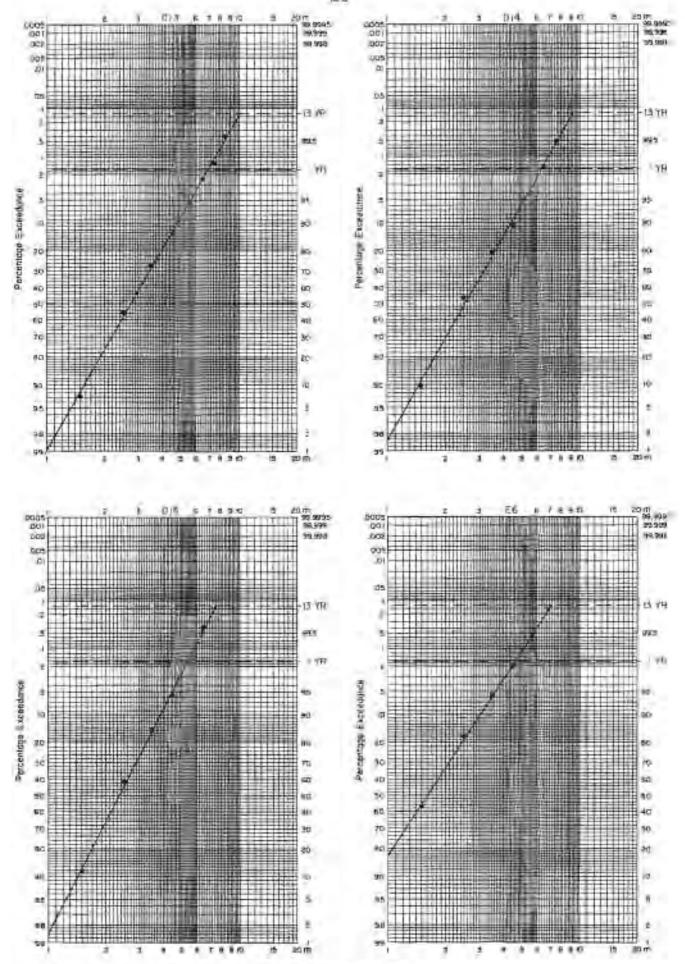


Figure 5m Monthly Wave Height Exceedance Distribution for May

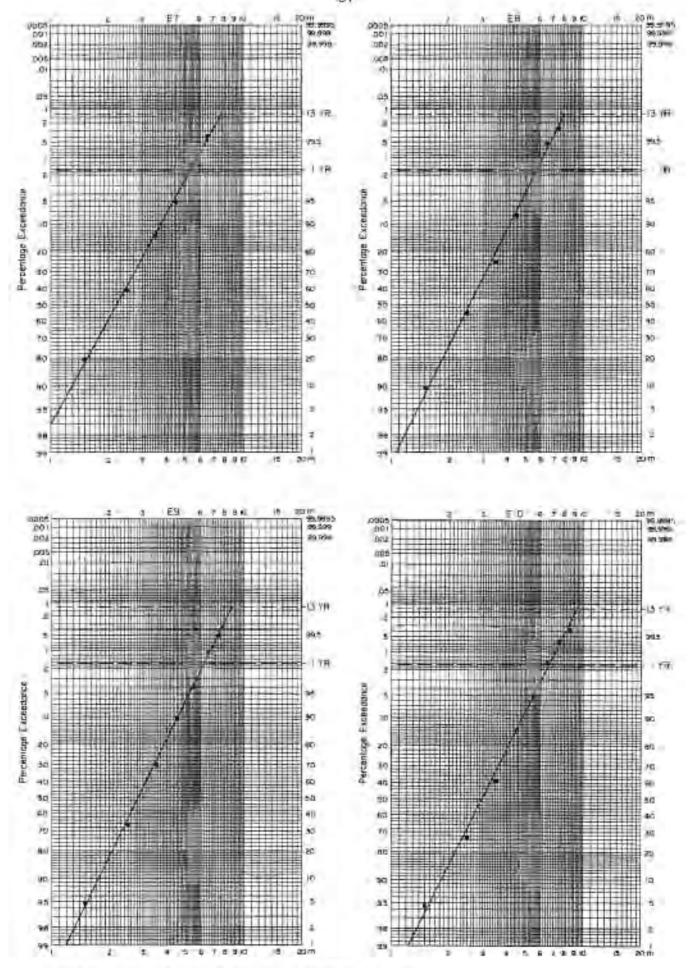


Figure 51 Monthly Ways Height Exceedance Distribution for May

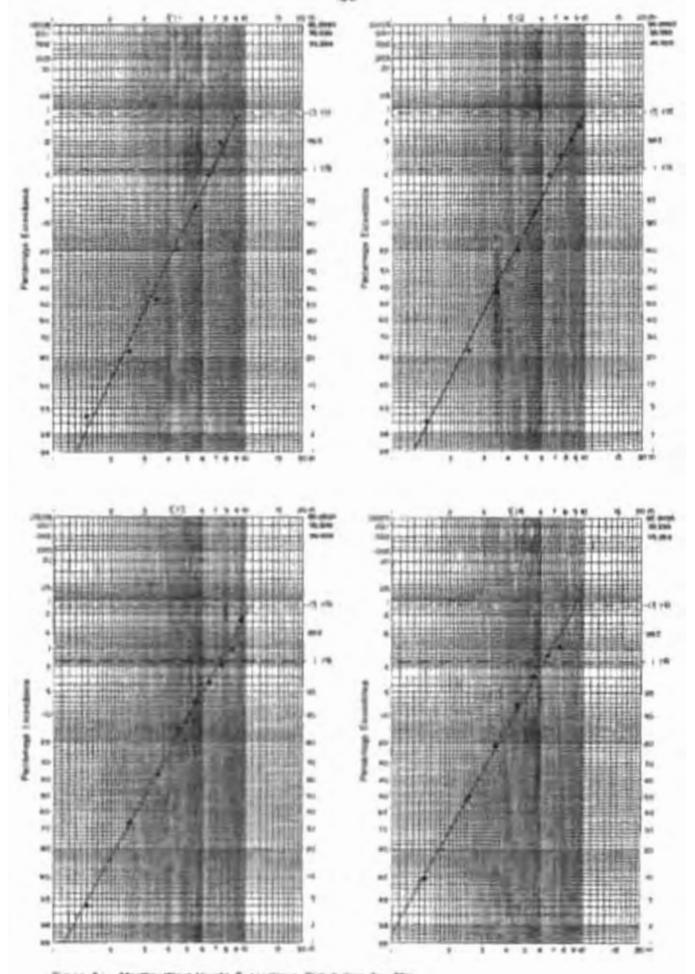


Figure 5: Monthly Wave Height Excentions Distribution for May

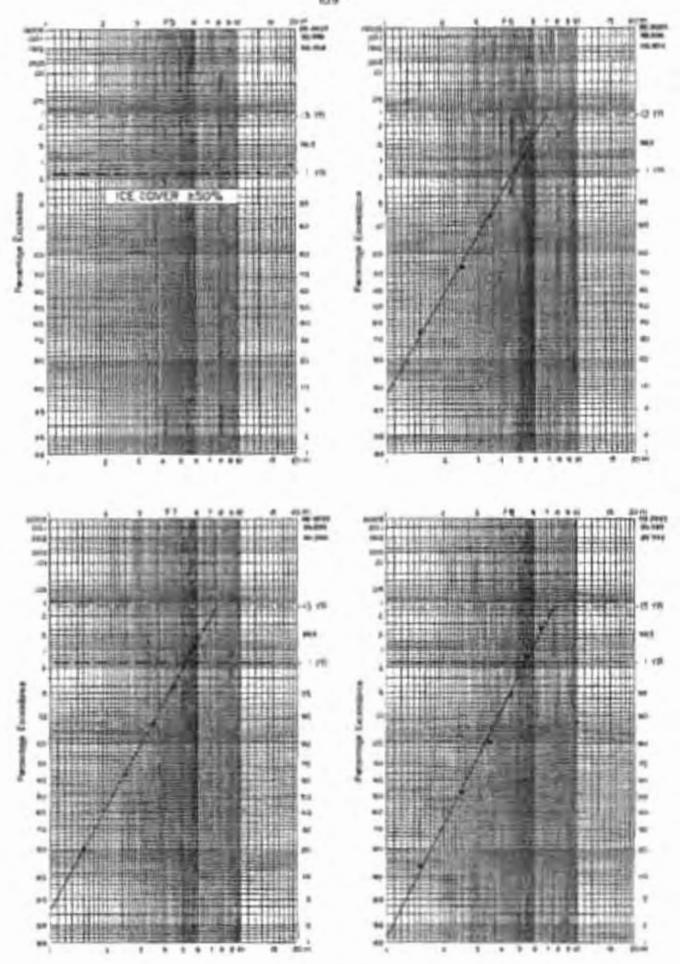


Figure to: Monthly Wove Height Excentance Distribution for Miles

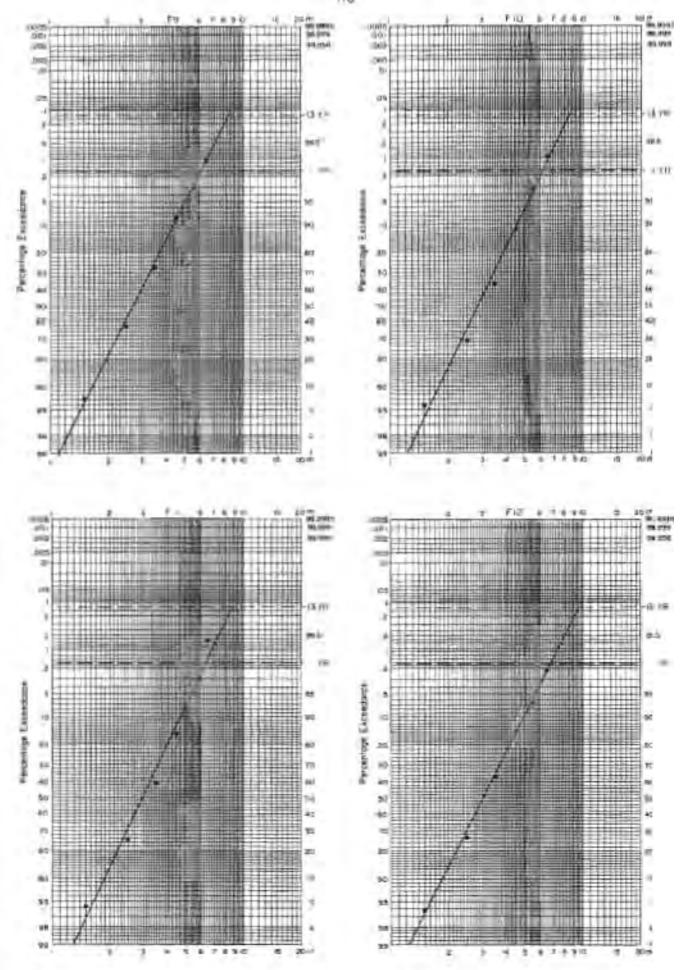


Figure 5a Monthly Wave Height Exceedance Distribution for May

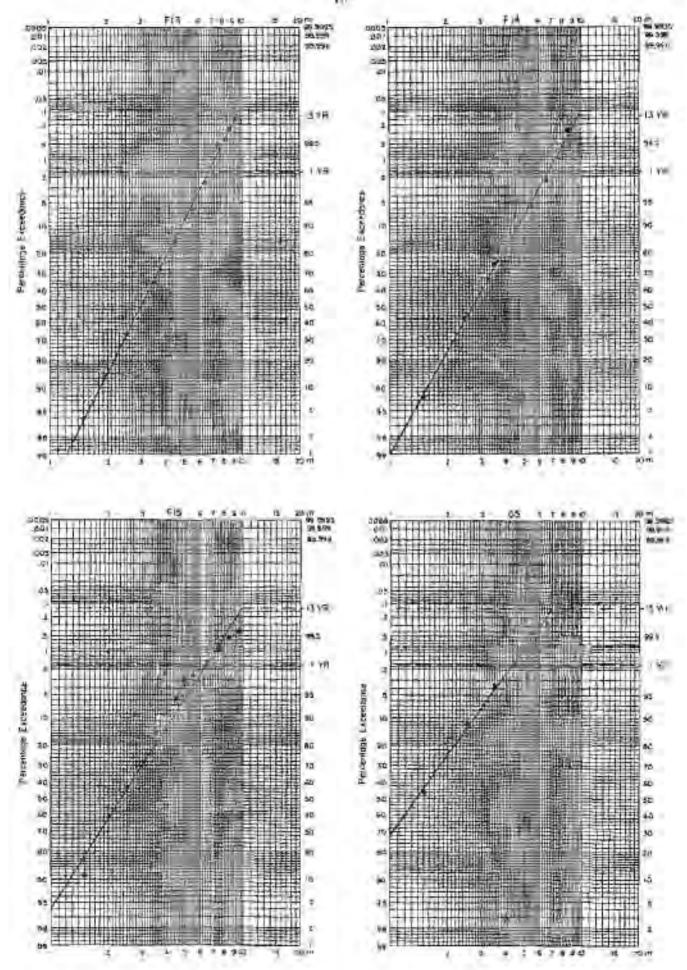


Figure 51 Monthly Wave Height Exceedance Distribution for May

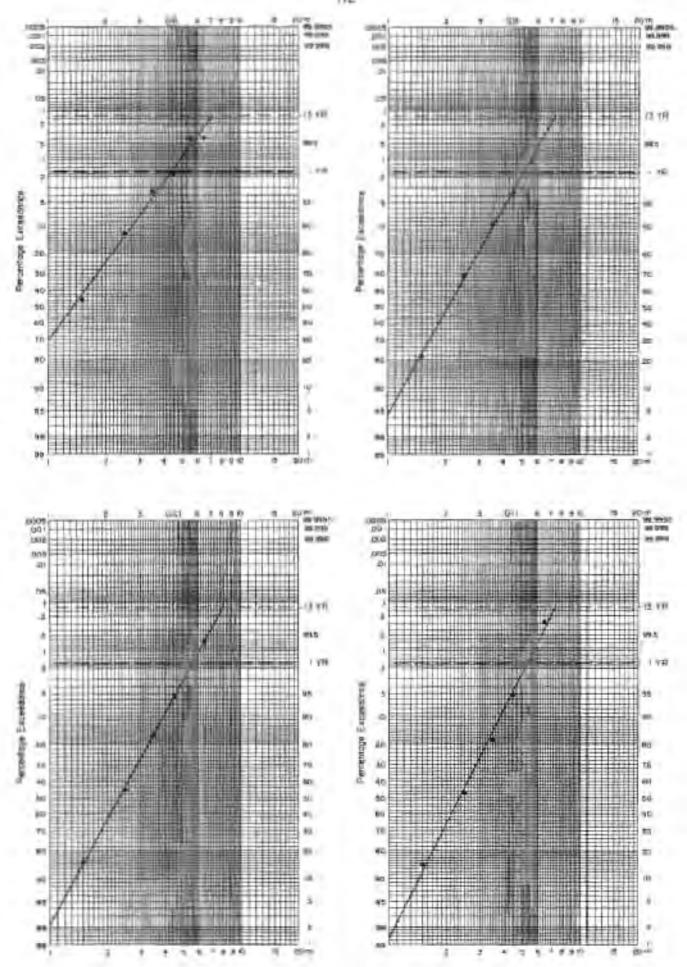
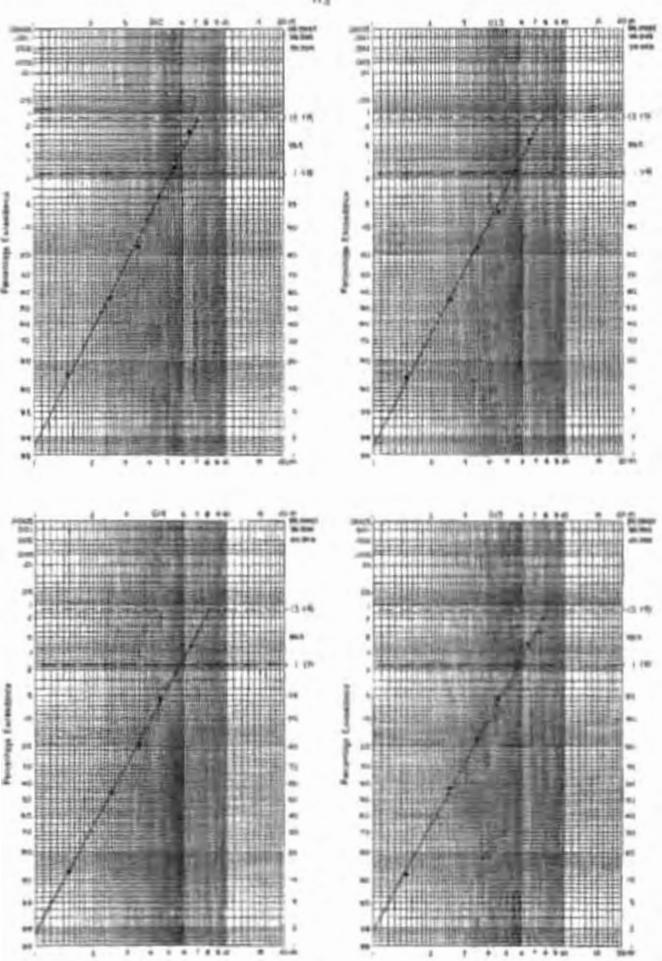


Figure Sil. Monthly Wave Height Exceedance Distribution for May



Fagure for Alterting Nove People Excendings Distribution for May

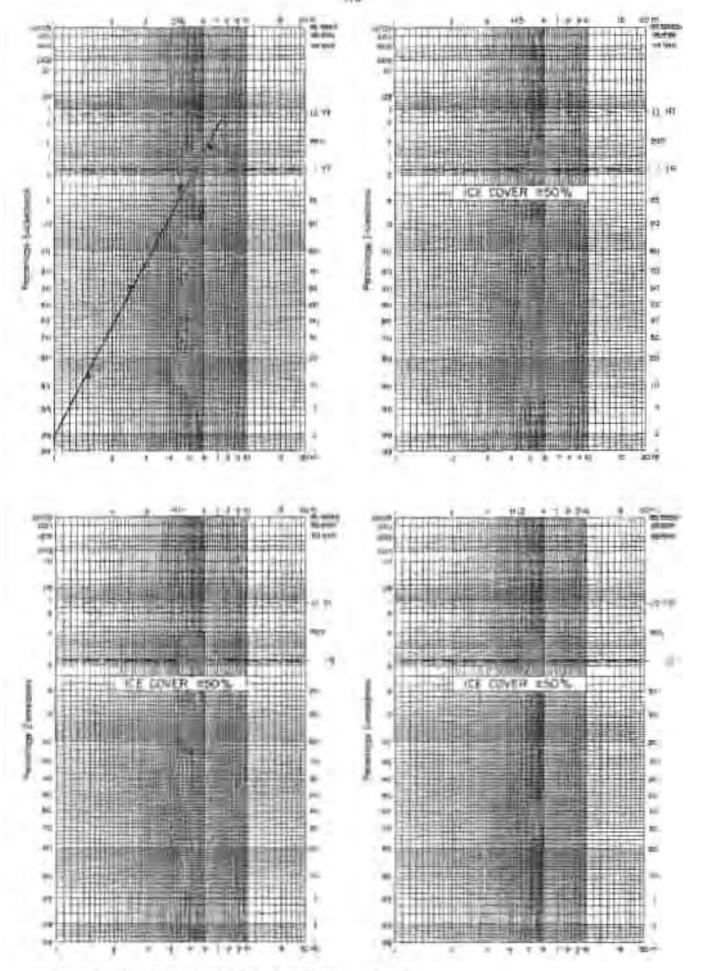
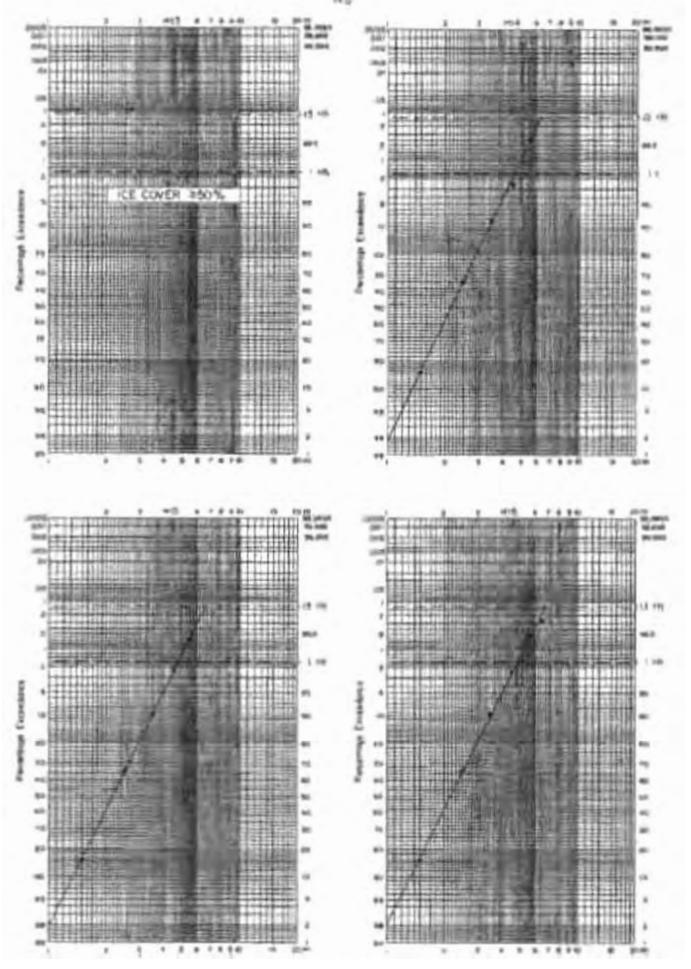
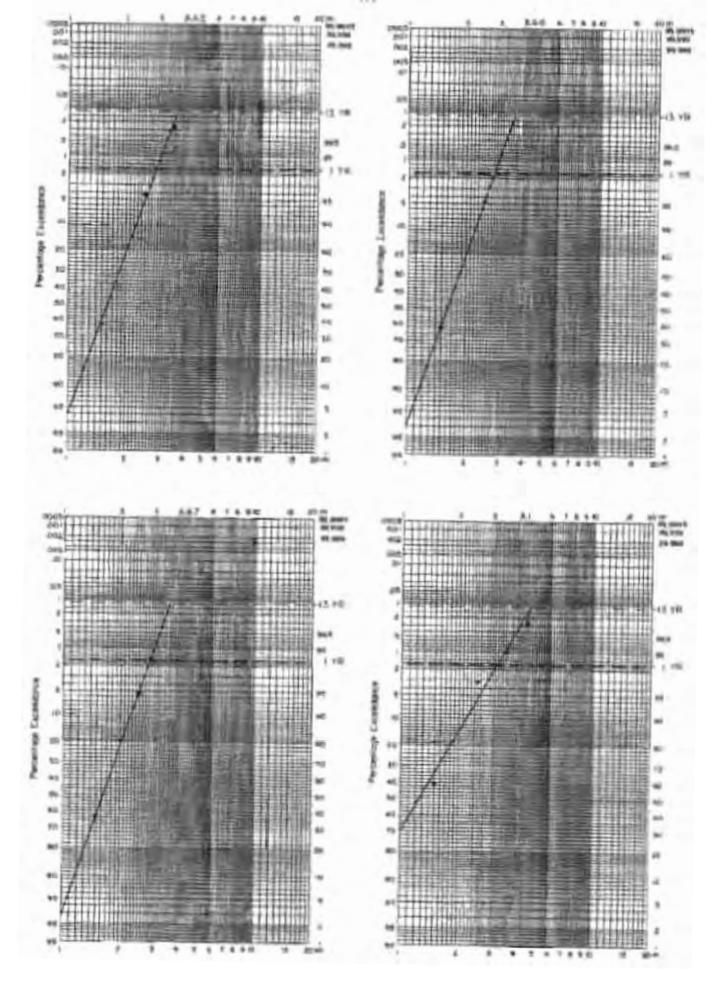


Figure to Marris Mose rangel Exceptions transmitted for May



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\* \* \* 4 7 7 7 7 1



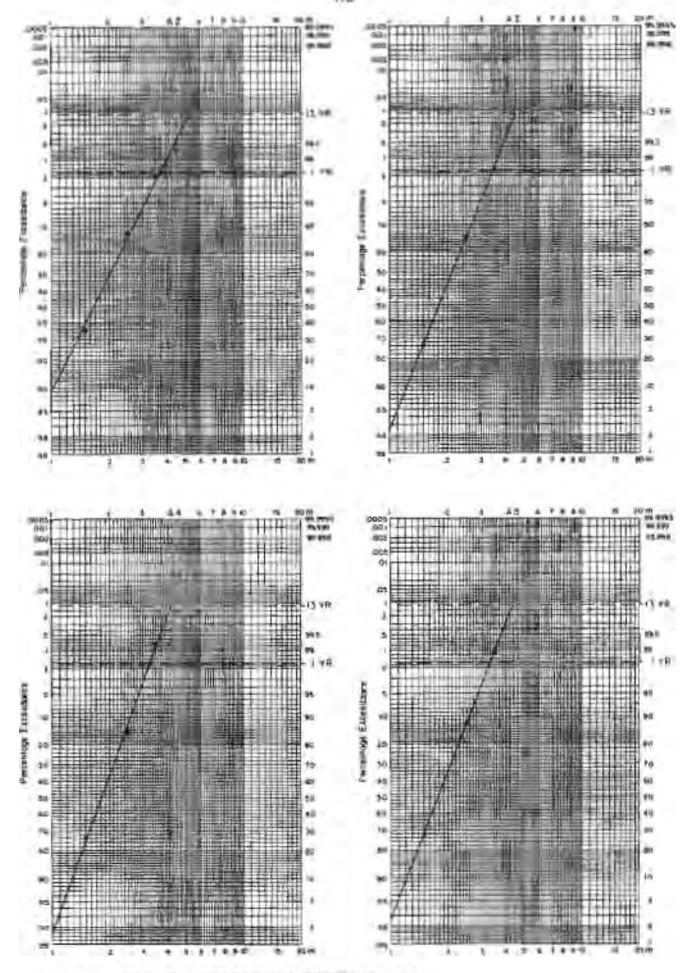
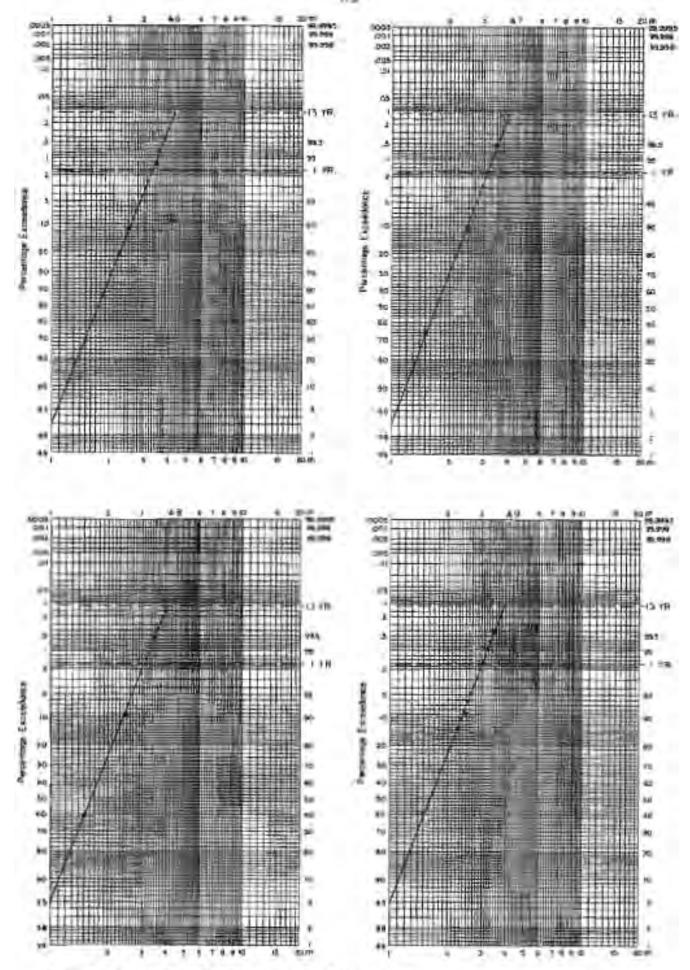
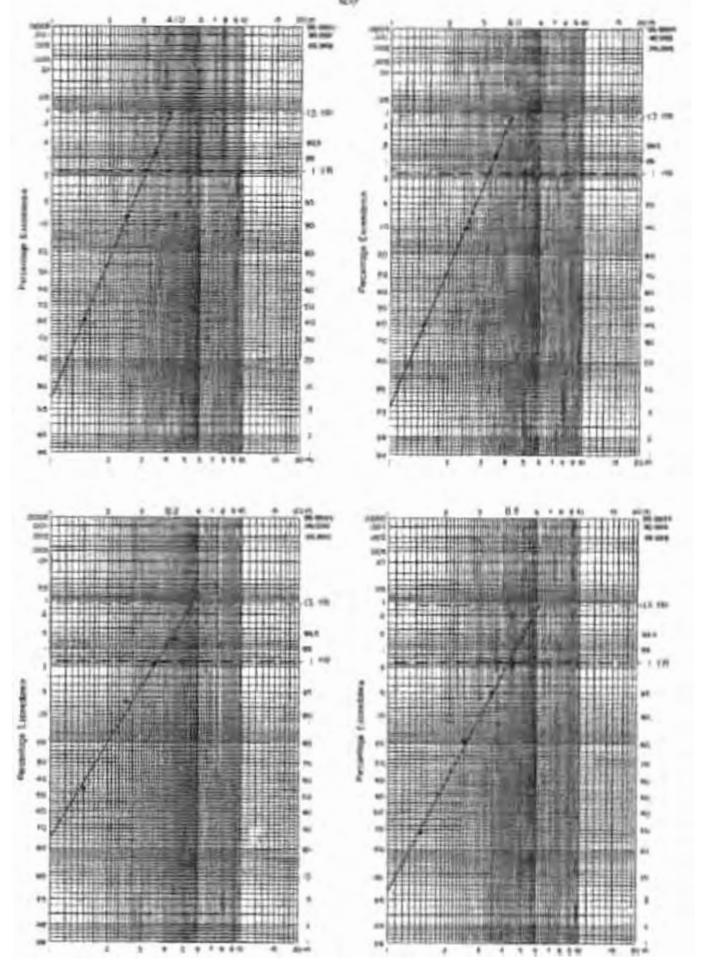
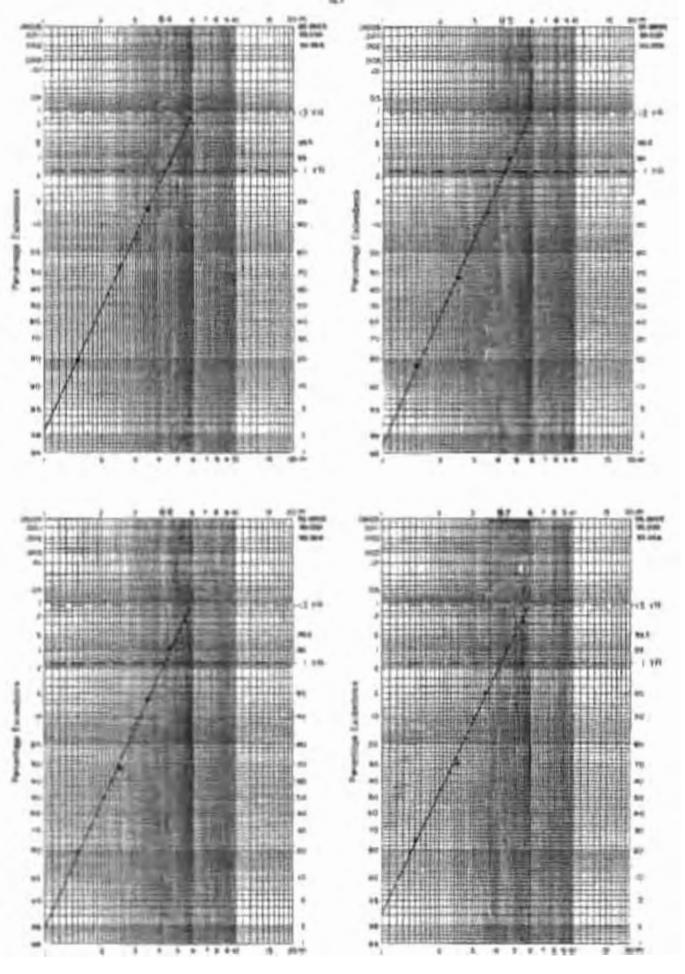


Figure Ac. Monthly Wave Height Excessionics Distribution for years



Flaure 64 Monthly Wave Height Exceedance Distribution for June





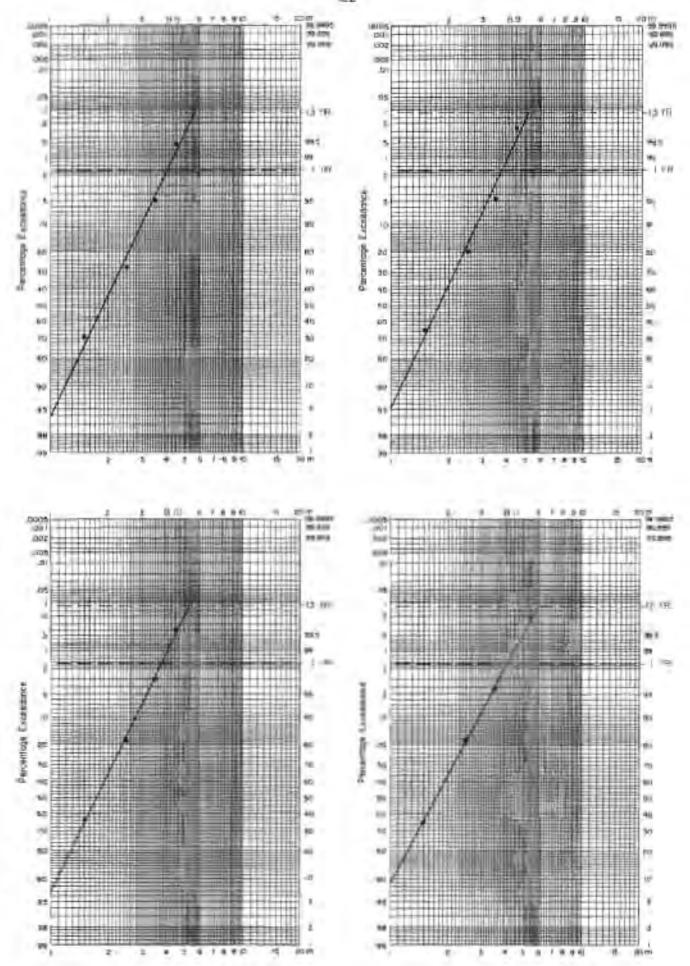


Figure 5q. Manthly Wave Height Exceedance Distribution for June

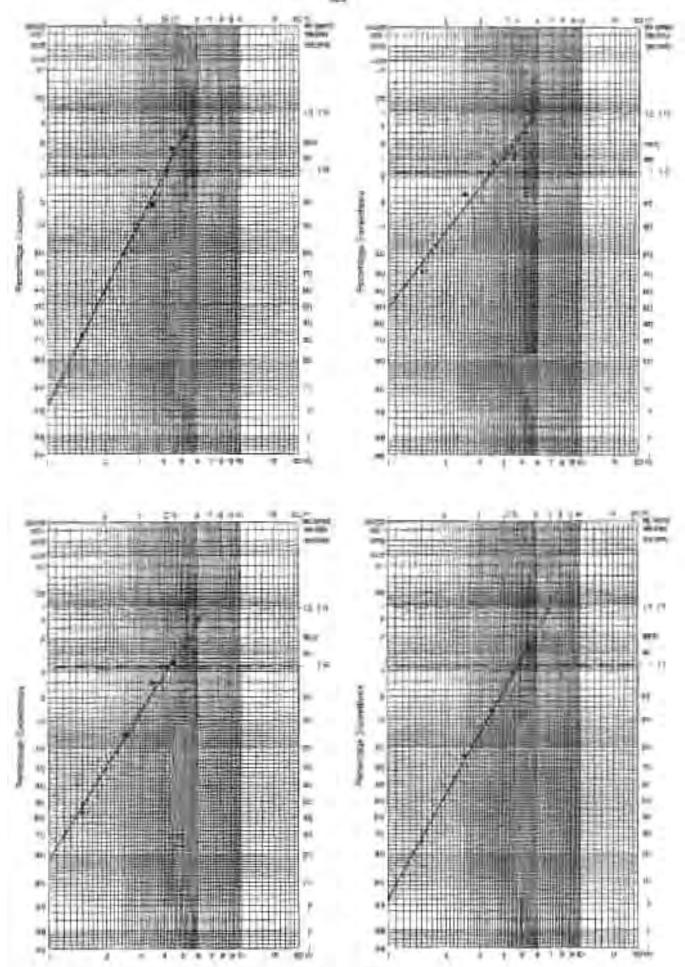


Figure &: Morthly Work I wight Exceedance Distribution for June

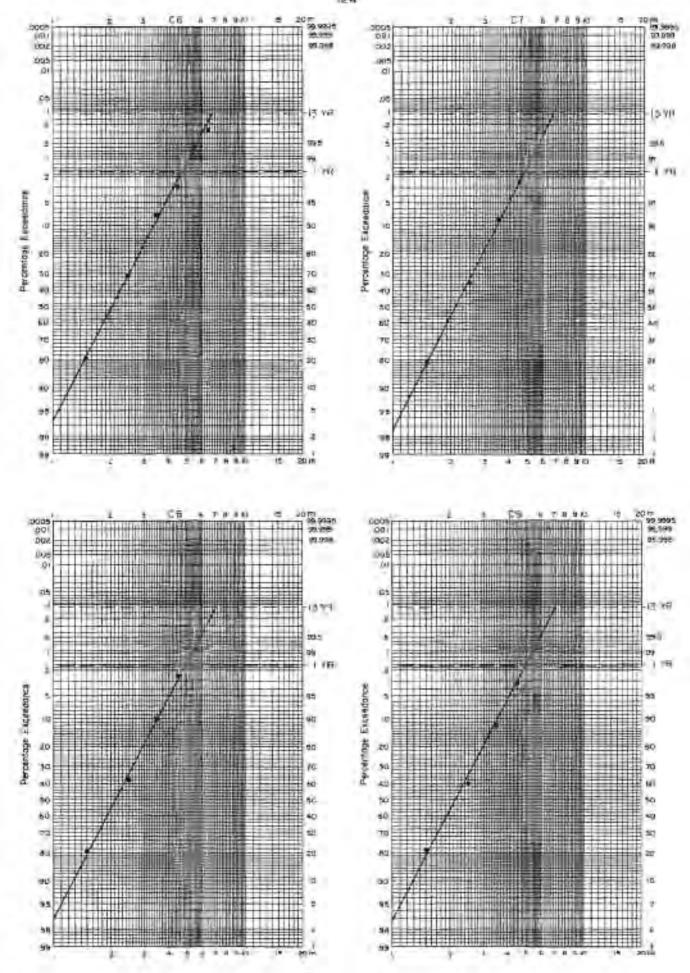


Figure 6. Monthly Wave Height Excendance Distribution for June

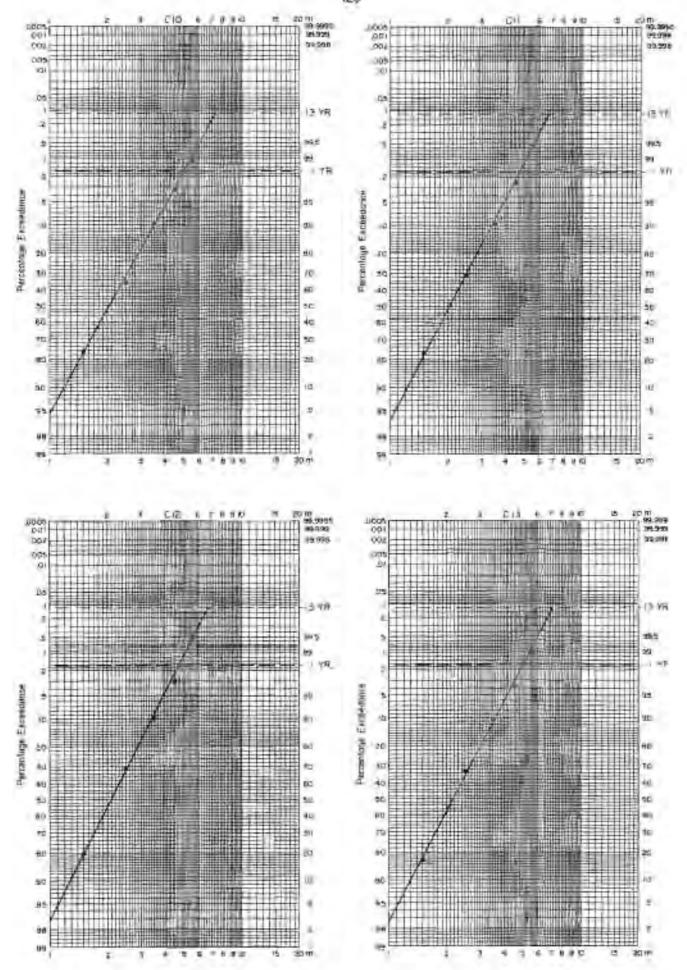


Figure 6) Monthly Wave Height Exceedance Distribution for June

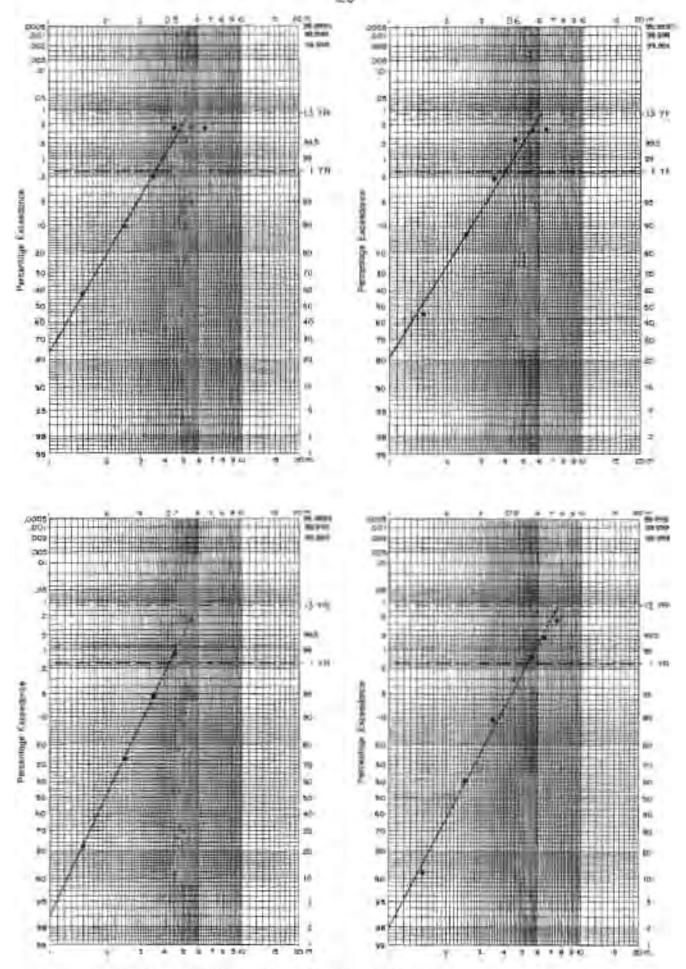


Figure 6k Monthly Wave Height Exceedance Distribution for June

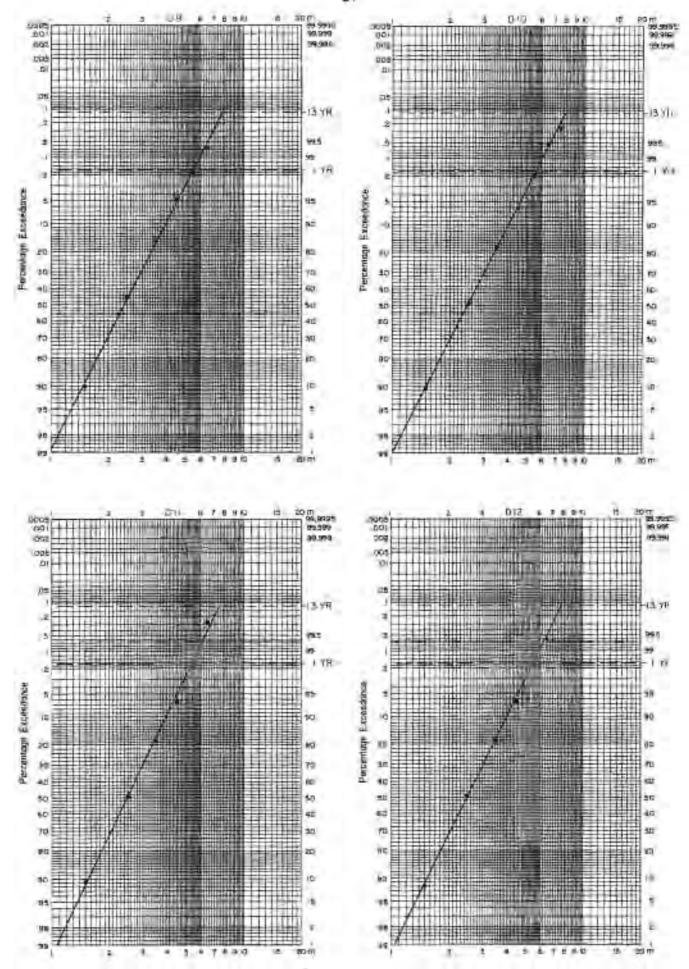


Figure 61 Monthly Wave Height Exceedance Distribution for June

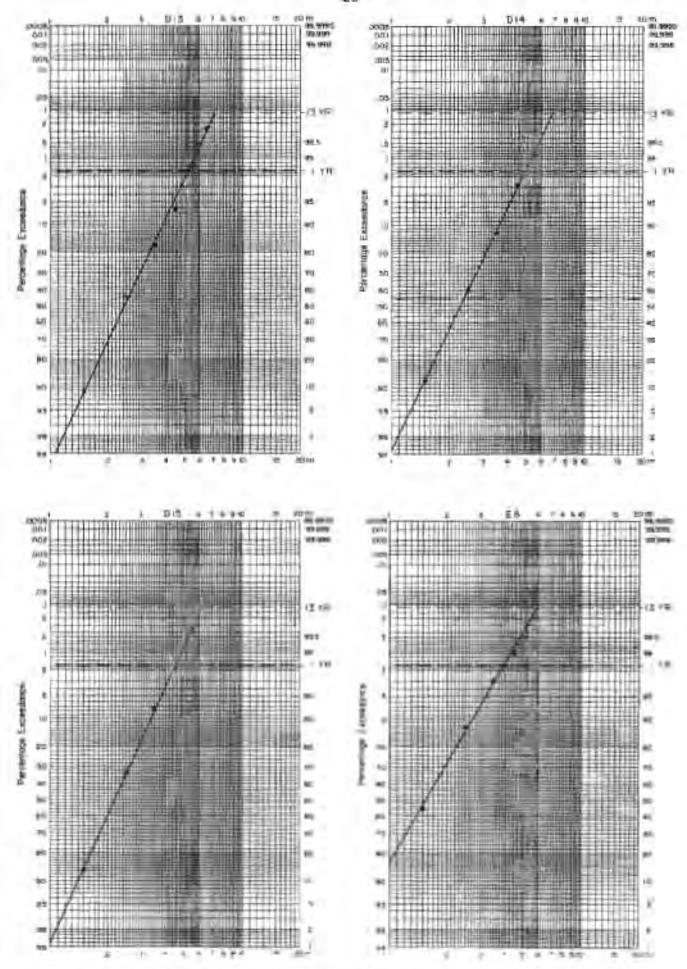


Figure 6.º Monthly Move Insight Exceedance Distribution for June

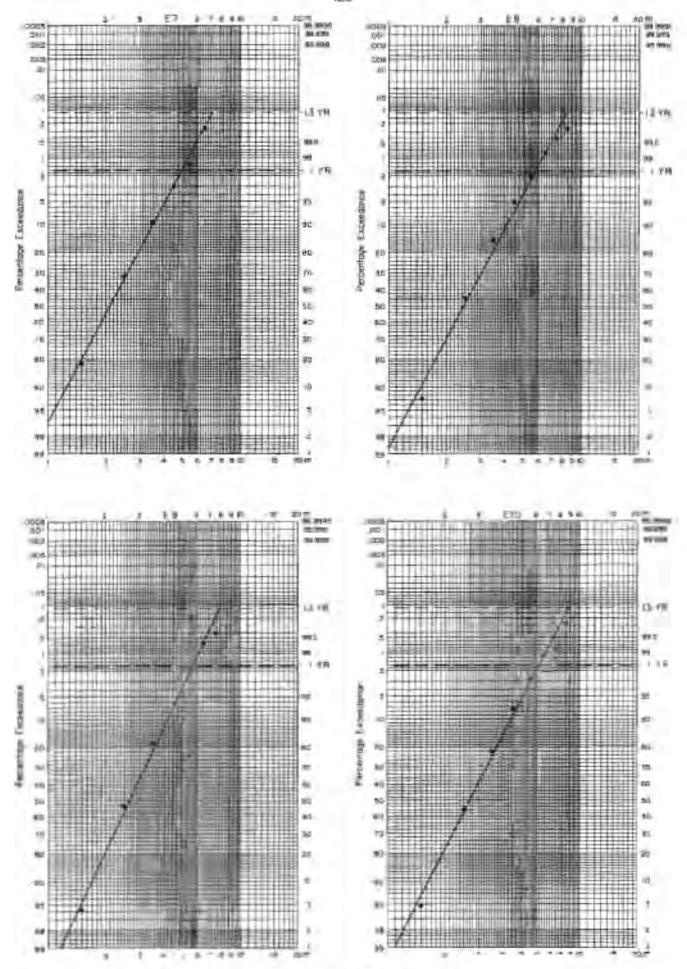
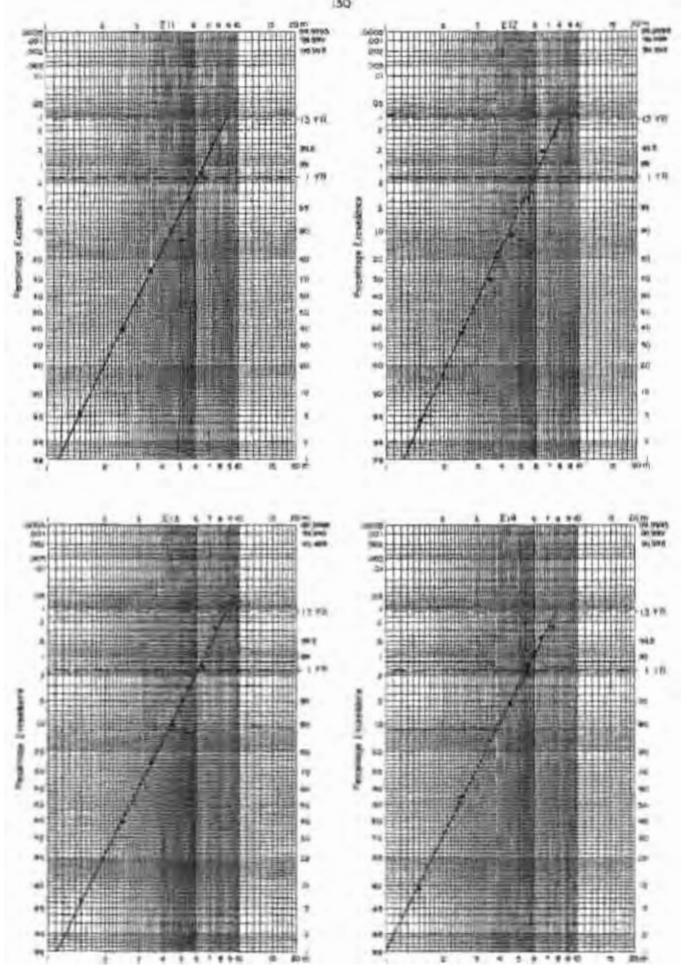


Figure Eri Monthly Wave Height Exceedance Distribution for June



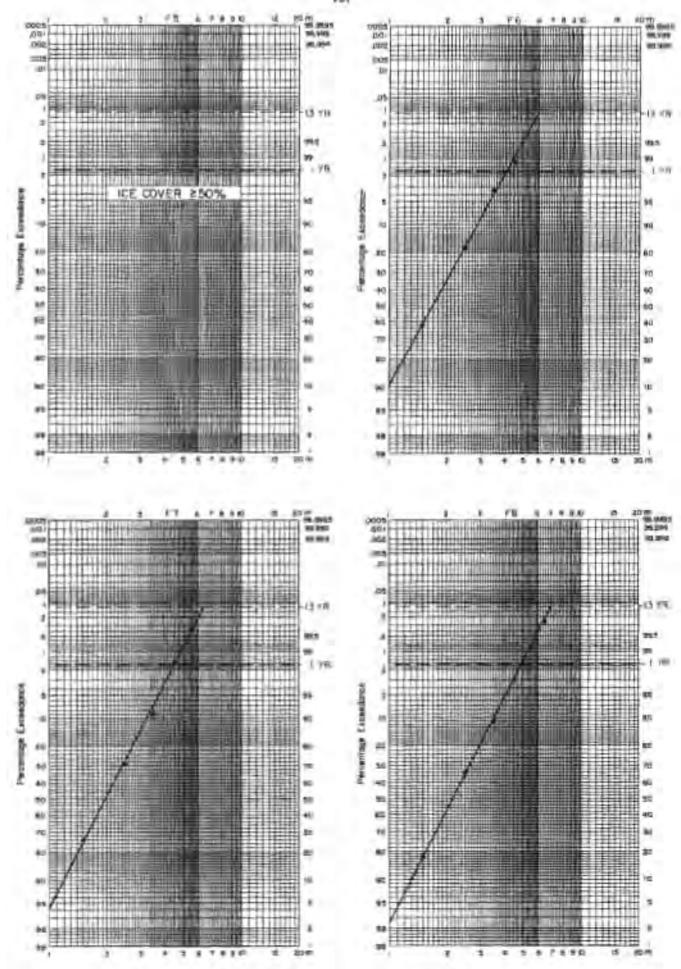
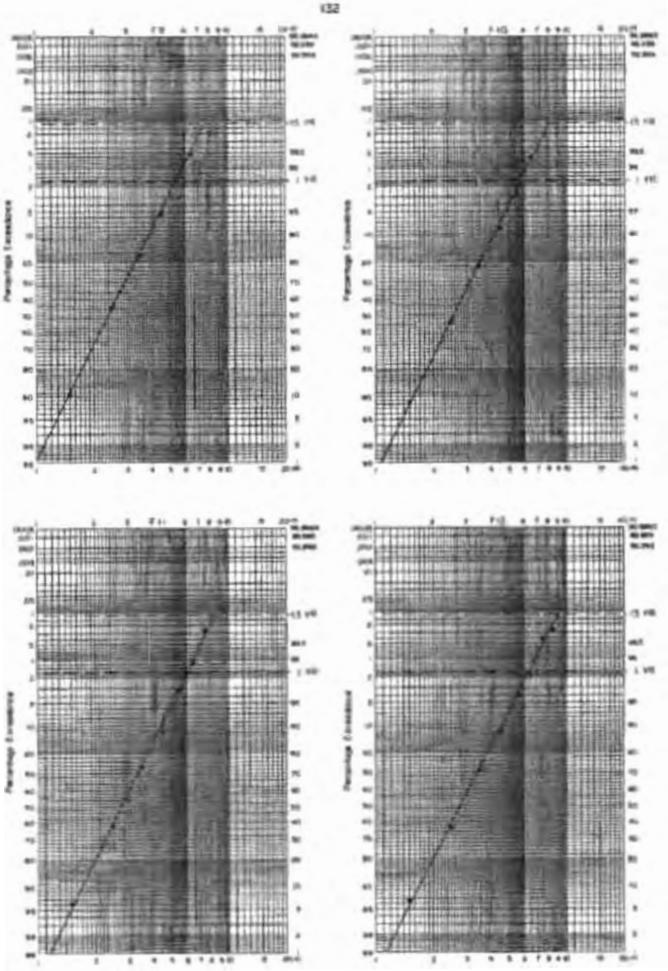


Figure 60: Monthly Wave Height Exceedance Distribution for June



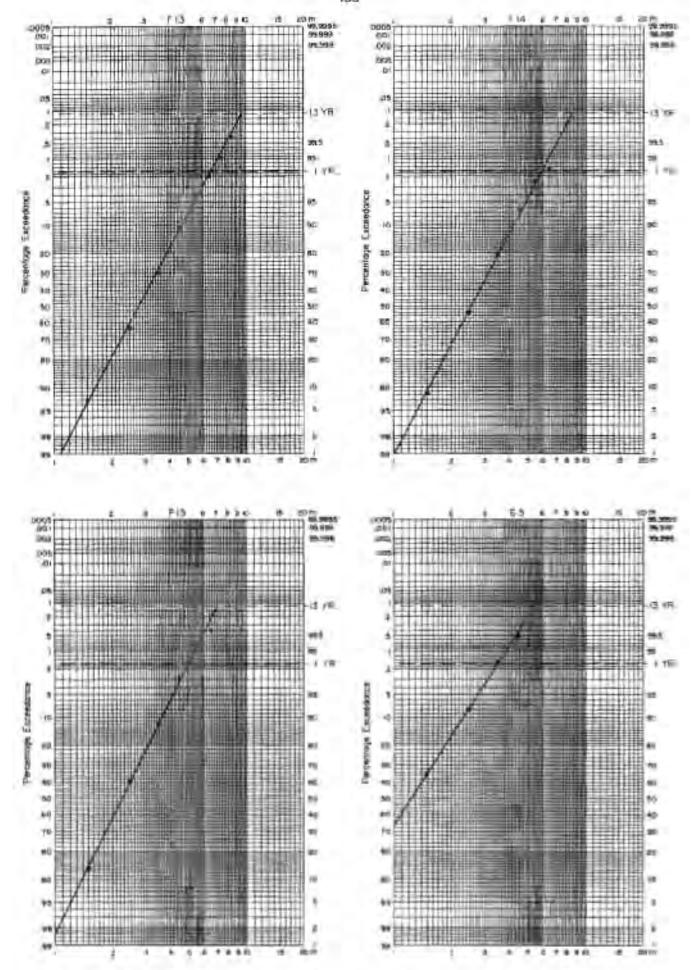


Figure III Monthly Wave Height Excendance Distribution for June

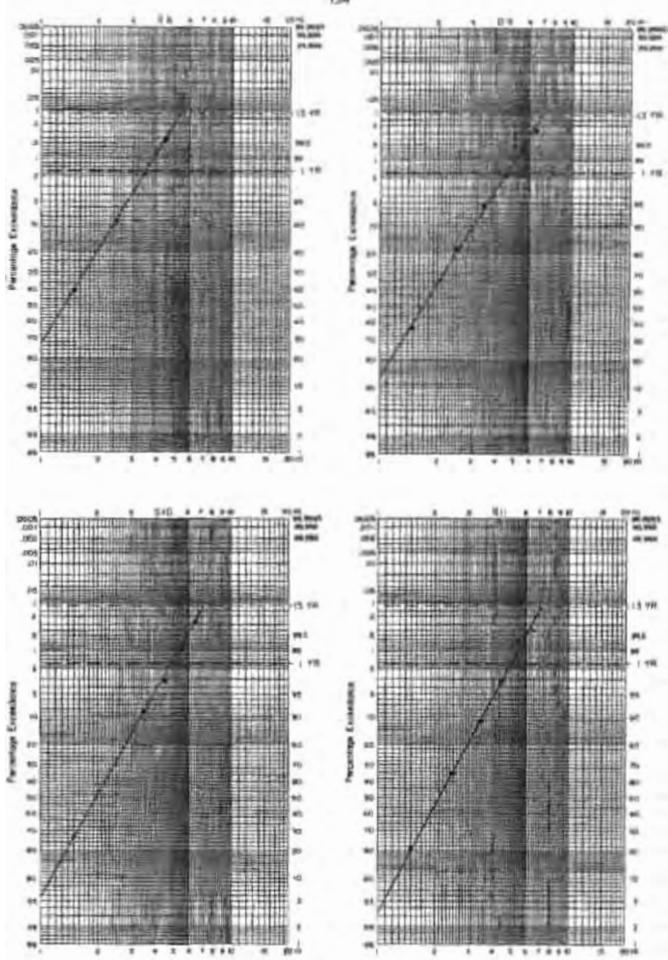


Figure 2s. Monthly Wave Height Excendions Distribution for Julie

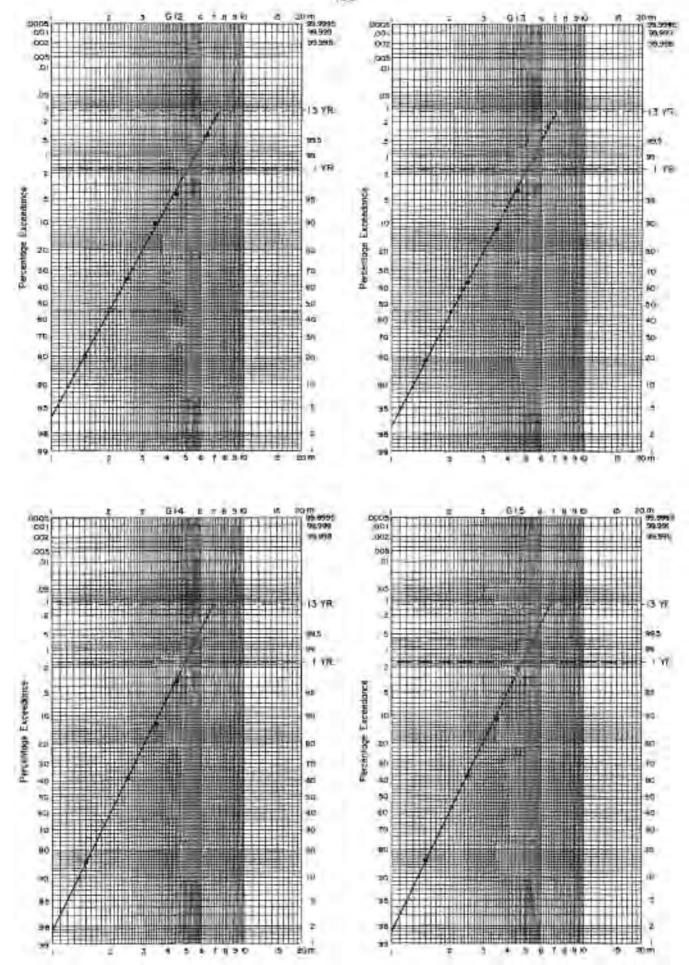
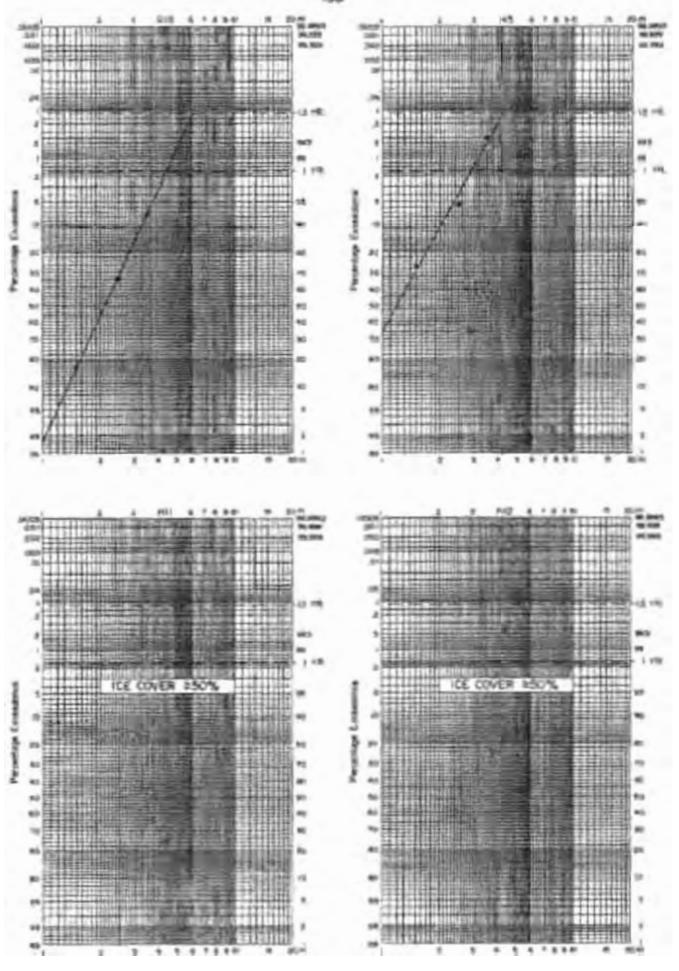


Figure 51. Monthly Wave Height Excendance Distribution for June



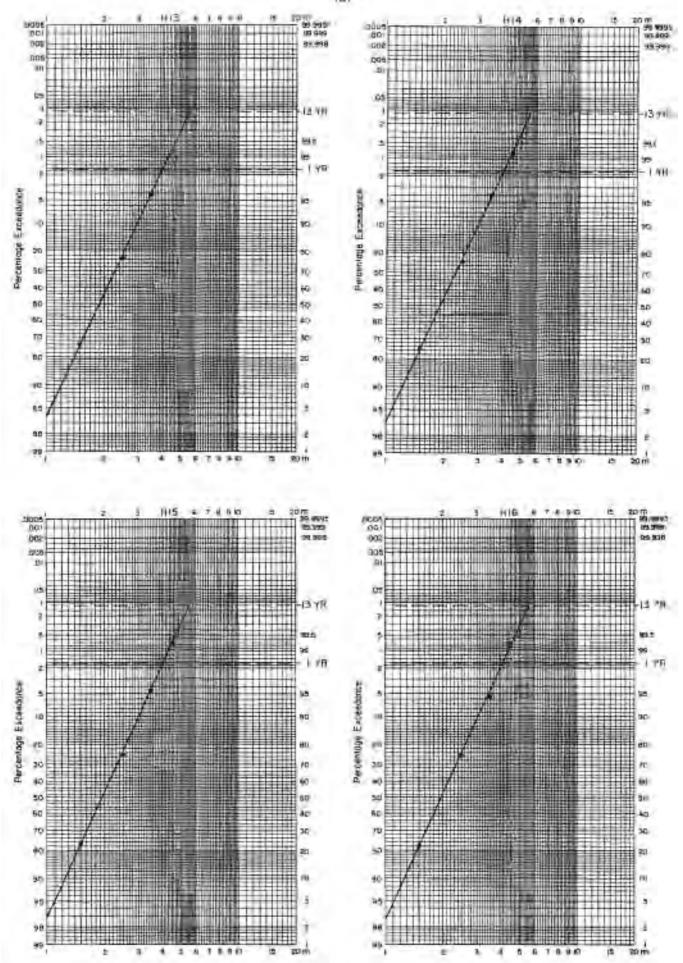


Figure 5: Monthly Wave Height Exceedance Distribution for June

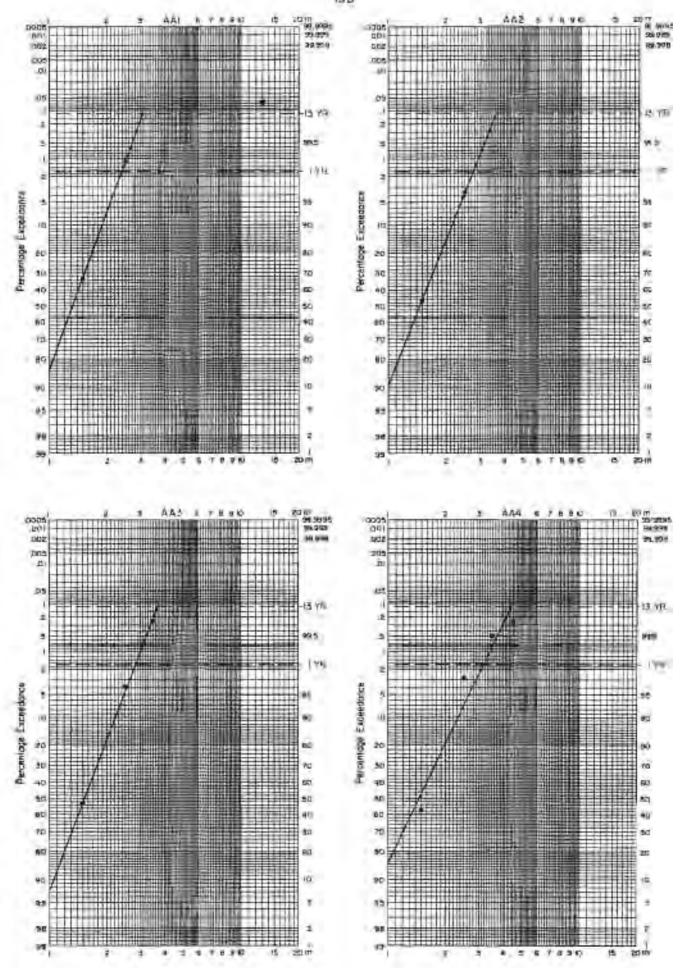
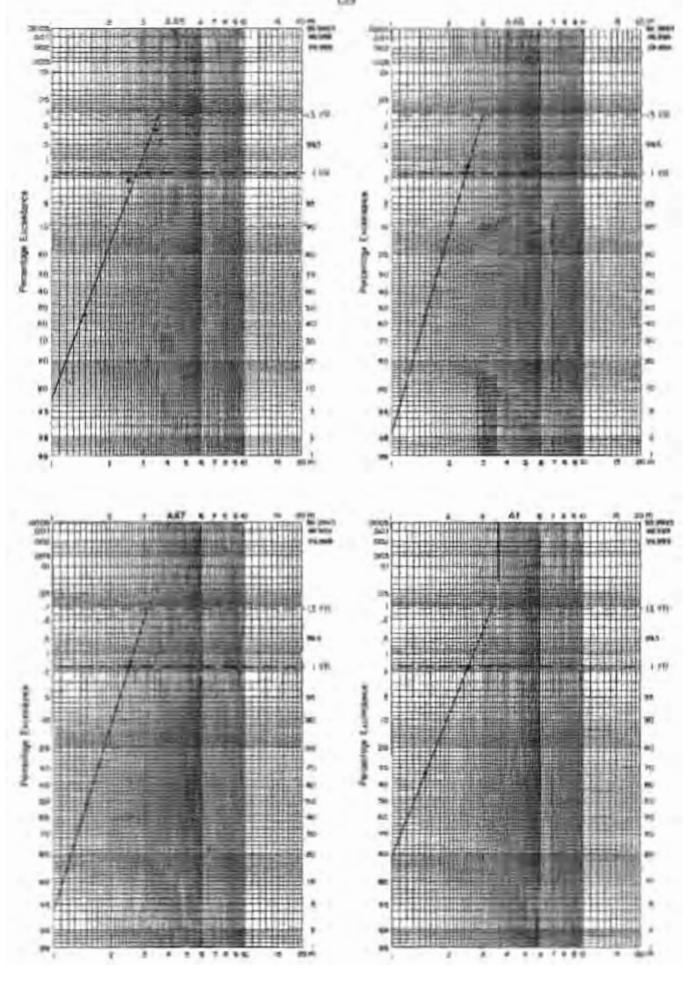


Figure 7d Monthly Wave Height Exceedance Distribution for July



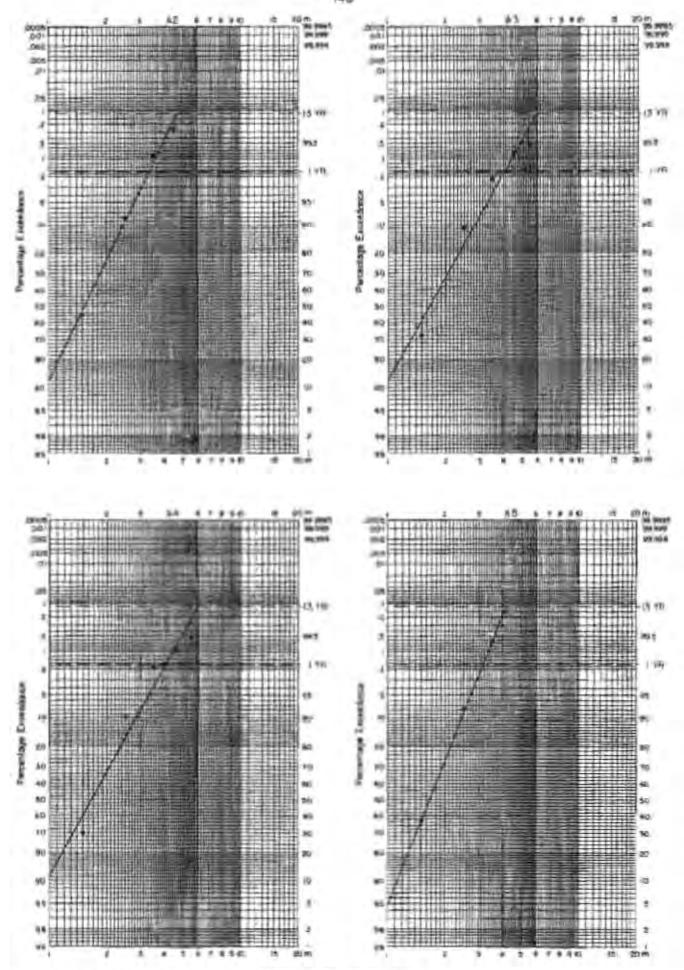


Figure 70. Monthly Wave Height Exceedance Distribution for study



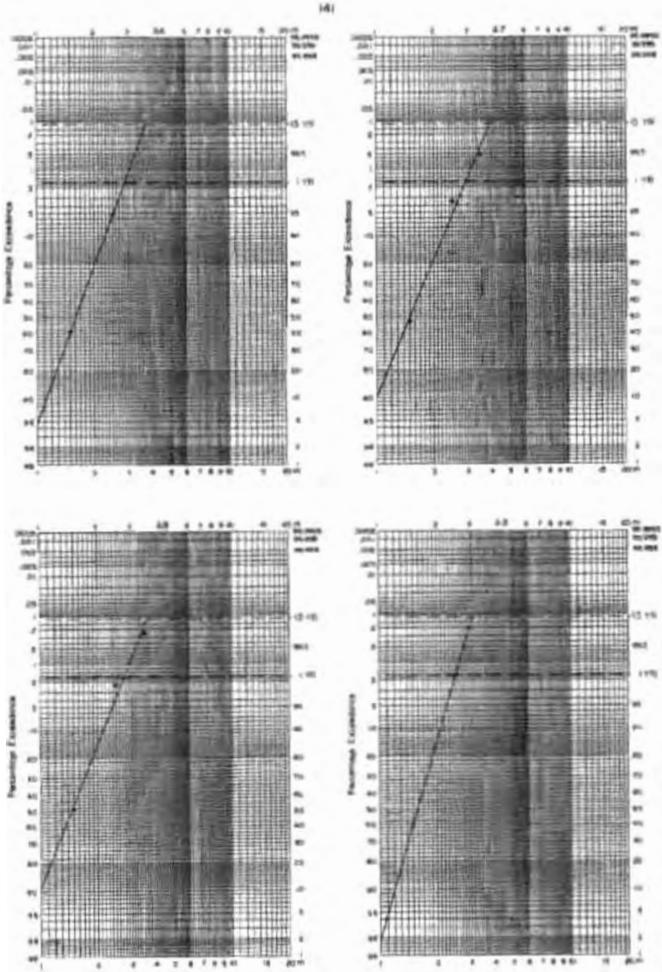


Figure Fit. Manthly Wave Haight Exceedance Distribution for July

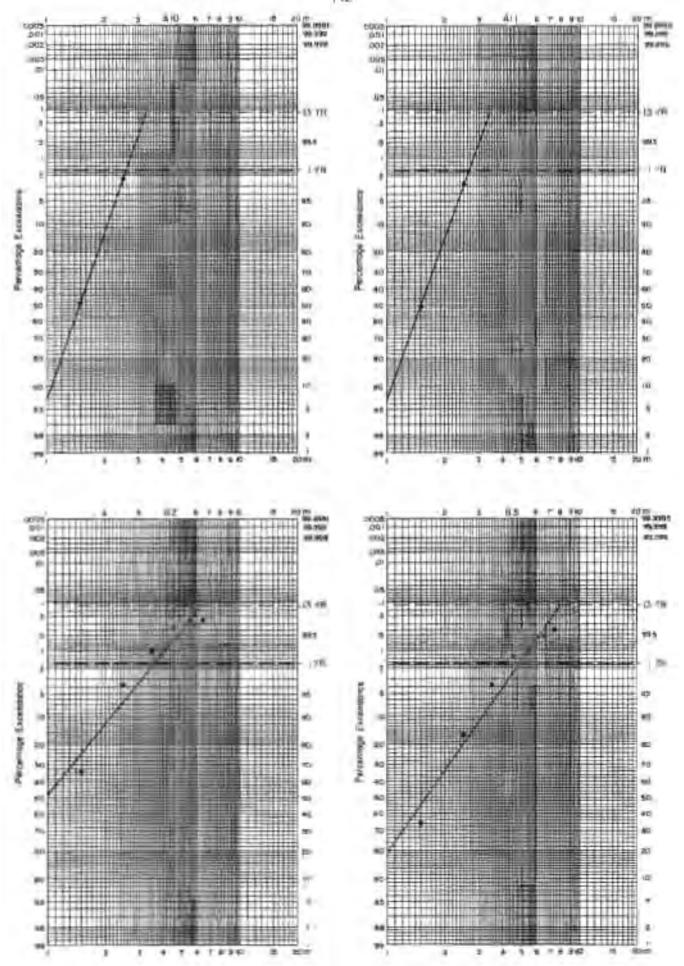


Figure 74. Monthly Wove Height Excendence Distribution for July

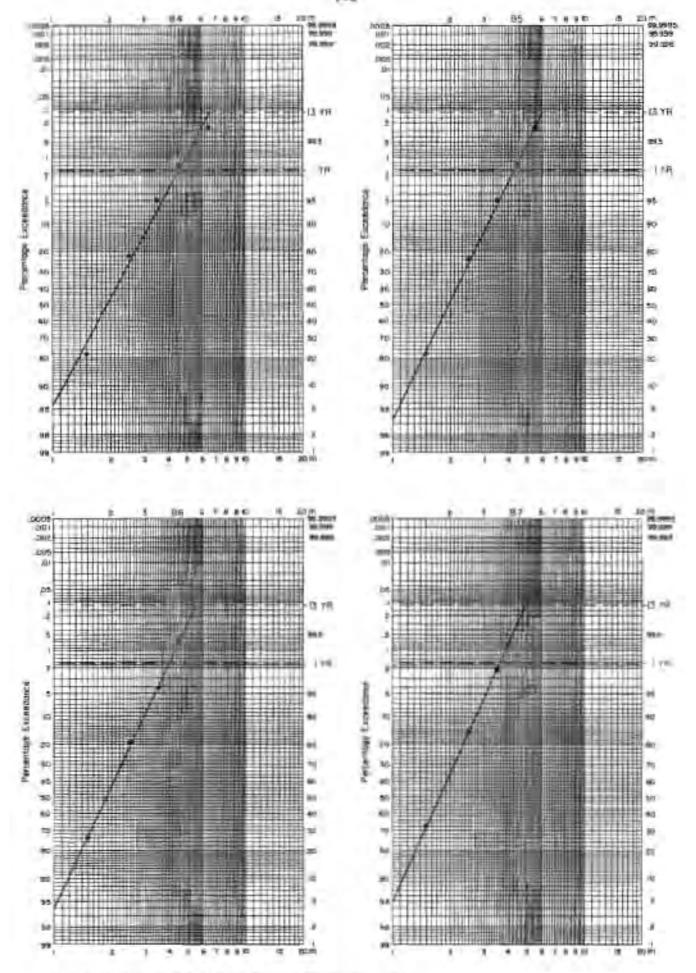
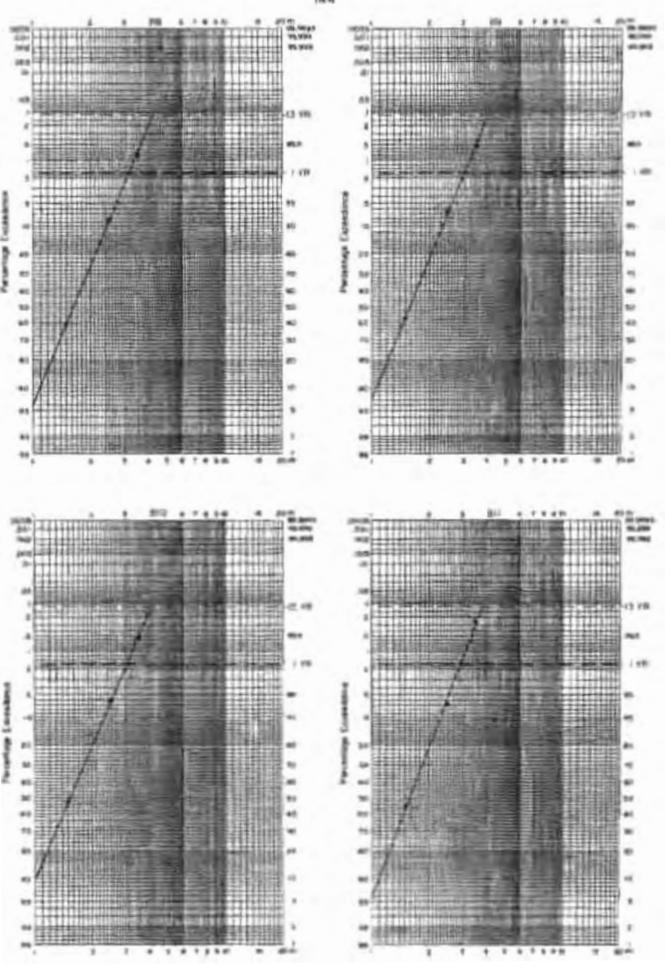


Figure 71 Monthly Wasse Height Exceptance Distribution for July



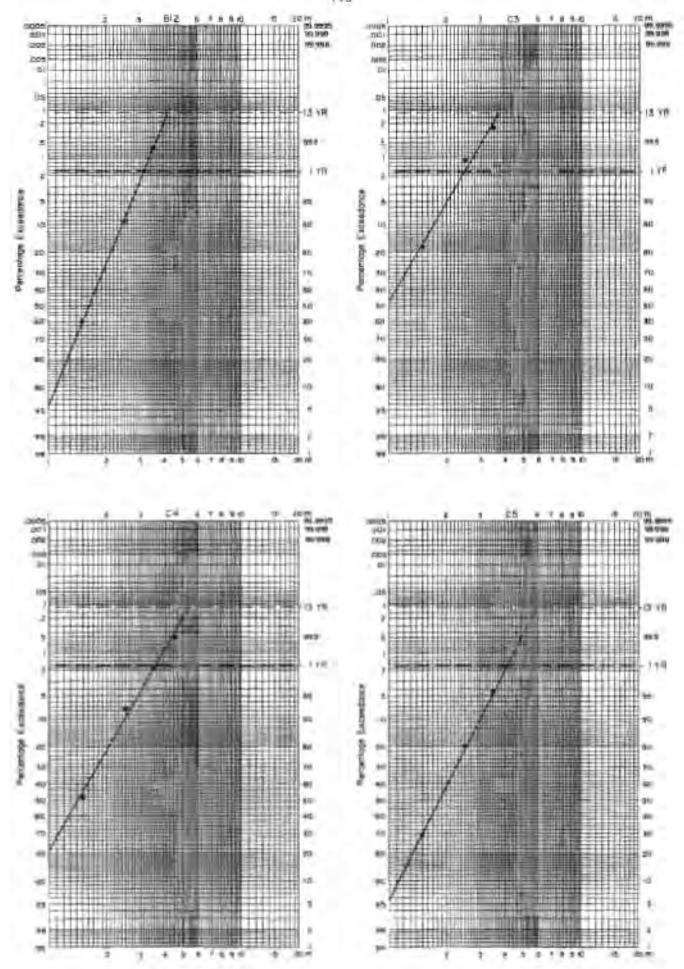


Figure 7th Monthly Wove height Escendance Oschibungs for July

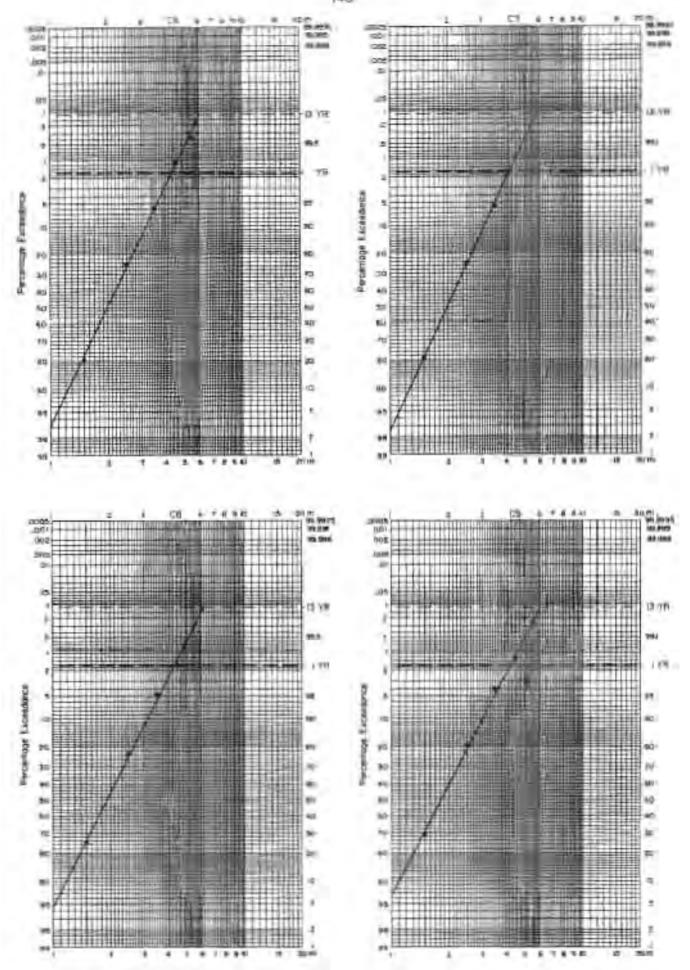
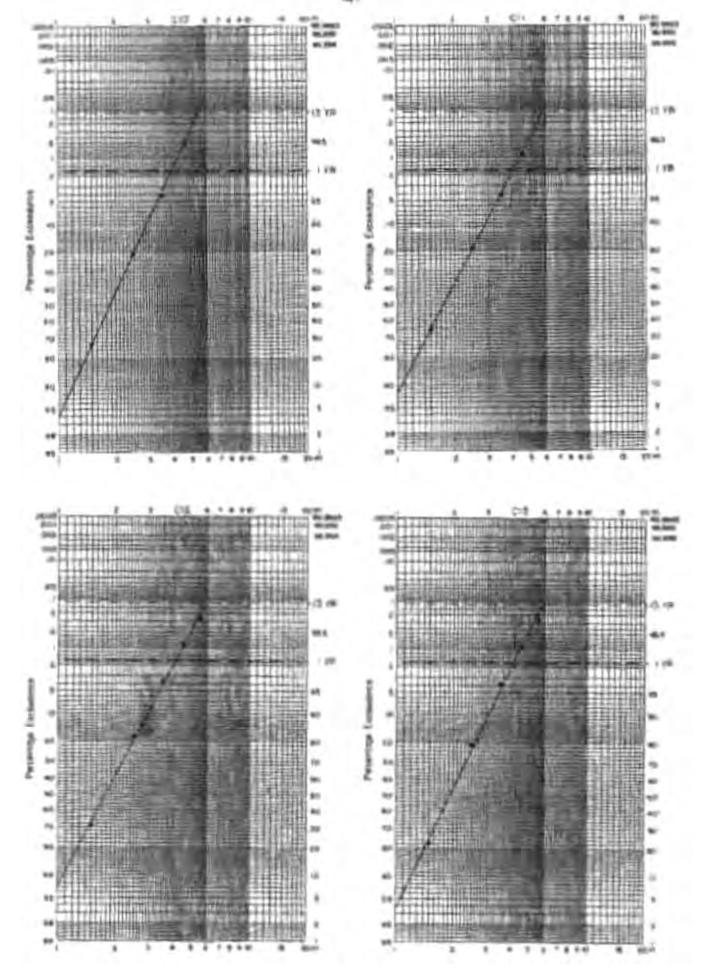


Figure 71 Monthly Wiles Height Exceptionce Distribution for July



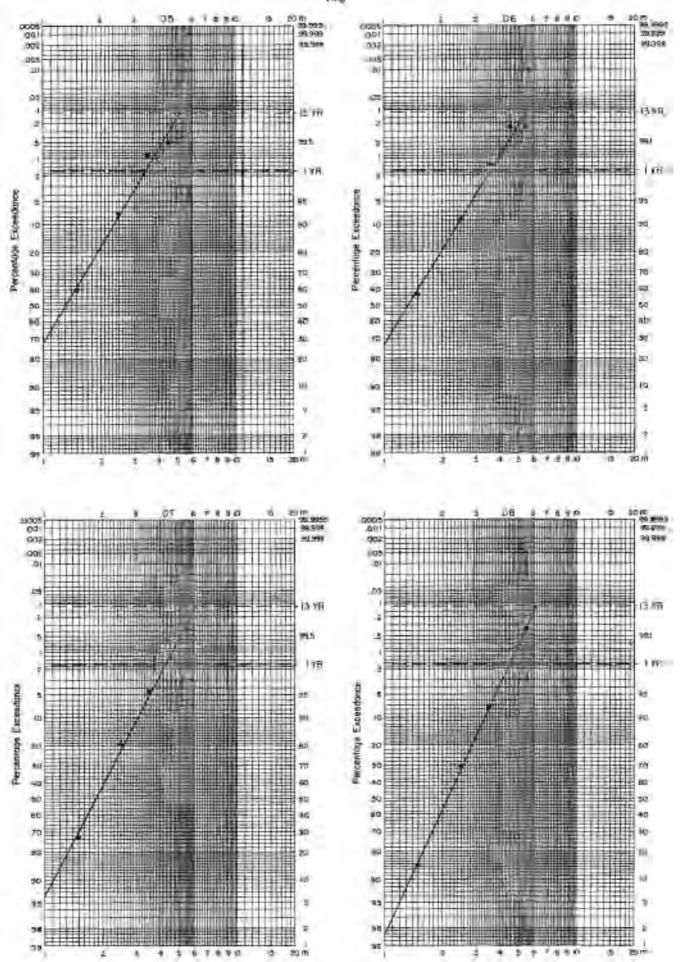


Figure 7) Monthly Wave Height Exceedance Distribution for July

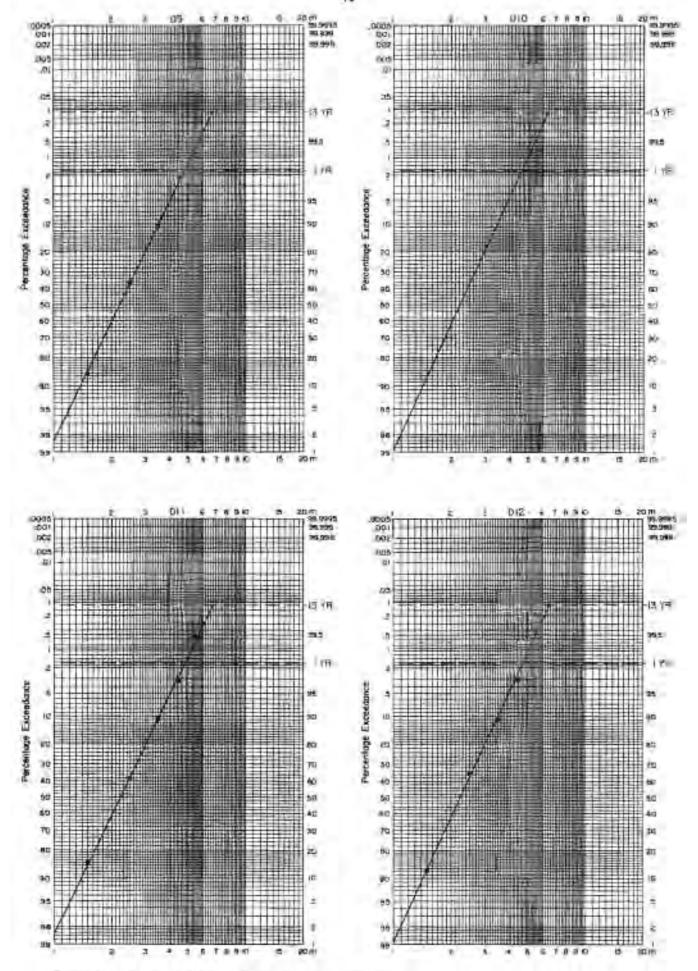


Figure 7: Manthly Waye Height Exceedance Distribution for July

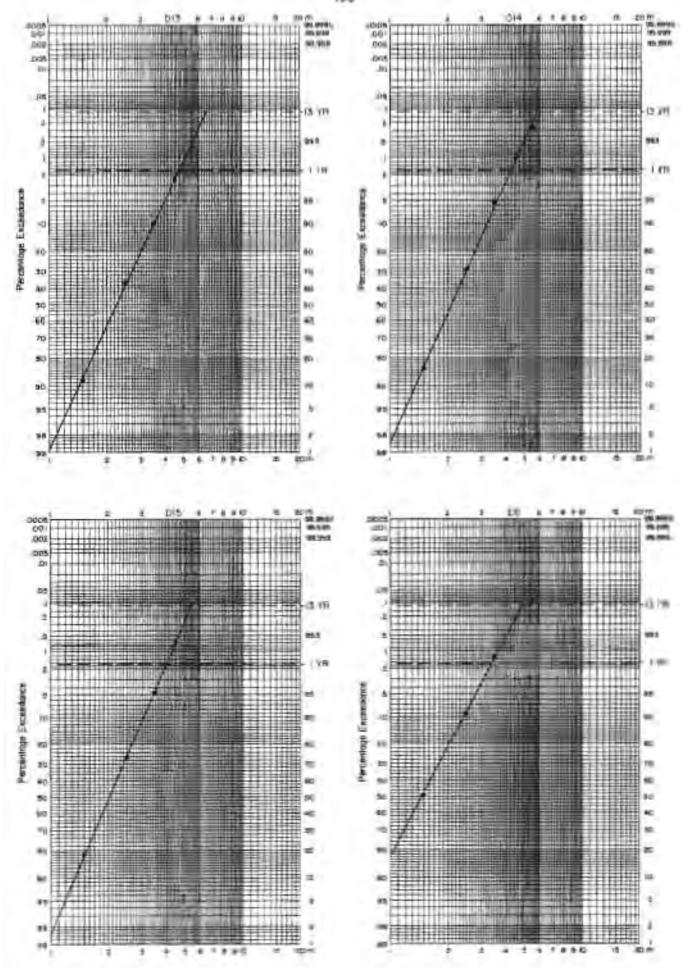
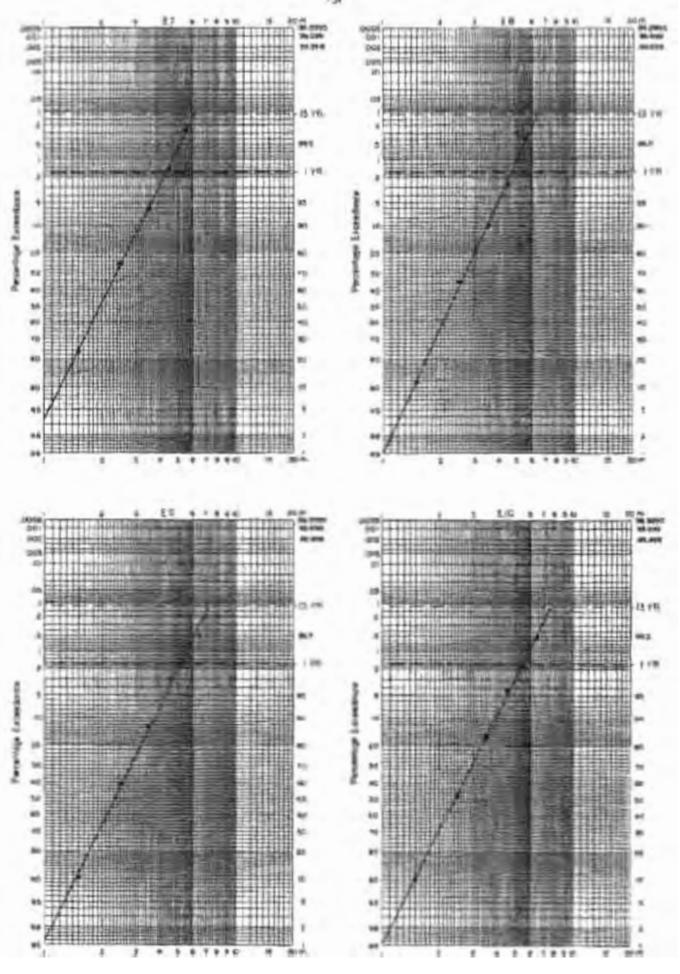


Figure 7m. Monthly Wave Height Excentional Distribution for July



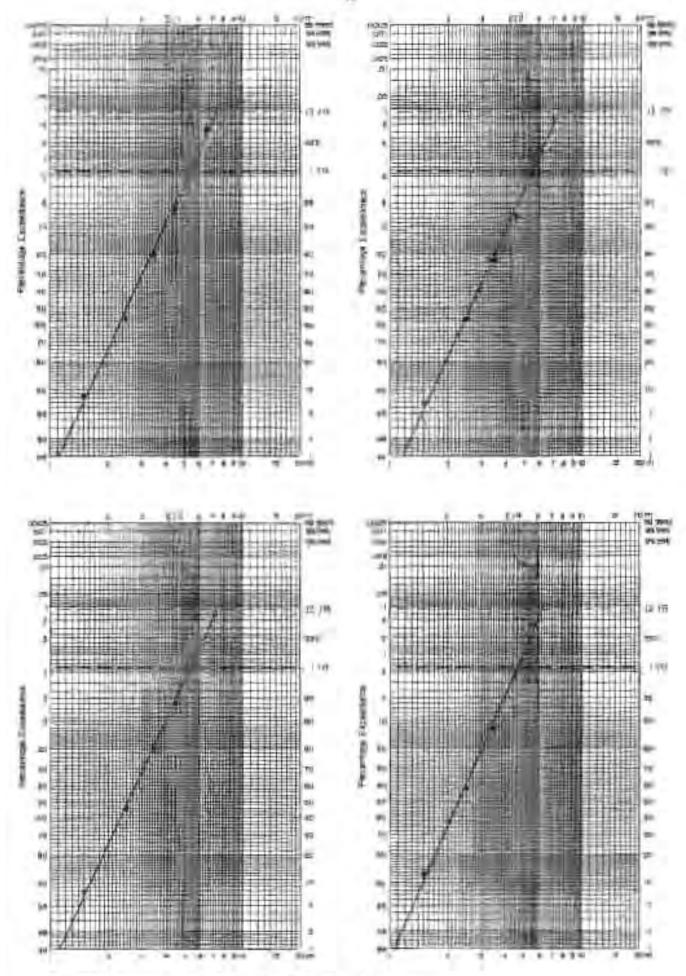


Figure To Marrier Assessment December Torribuser for one

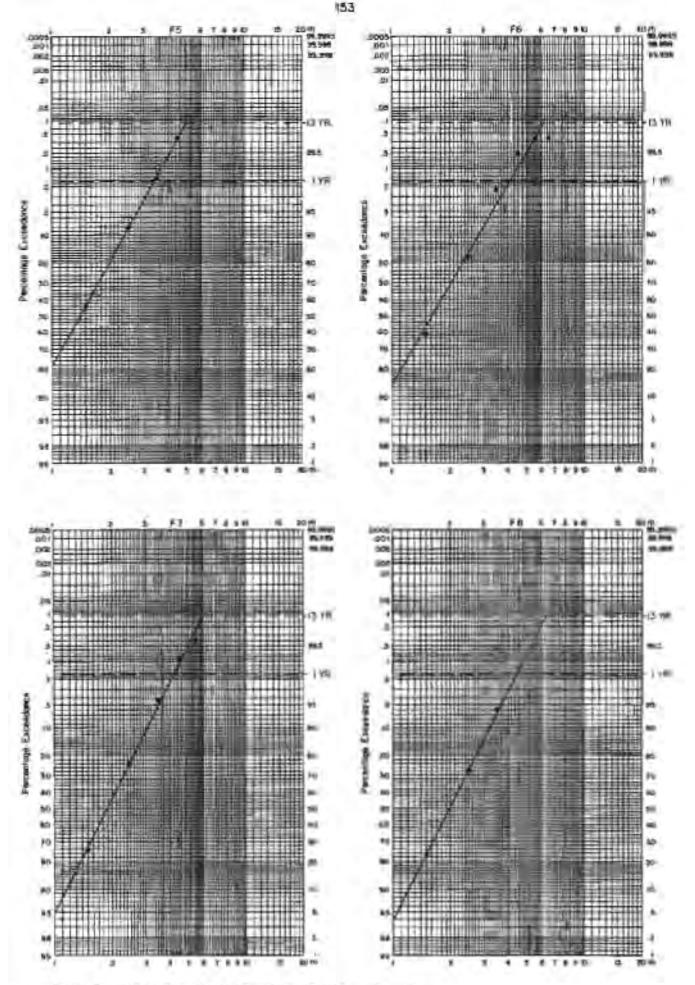


Figure 7p. Monthly Wave Height Exceedance Distribution for July



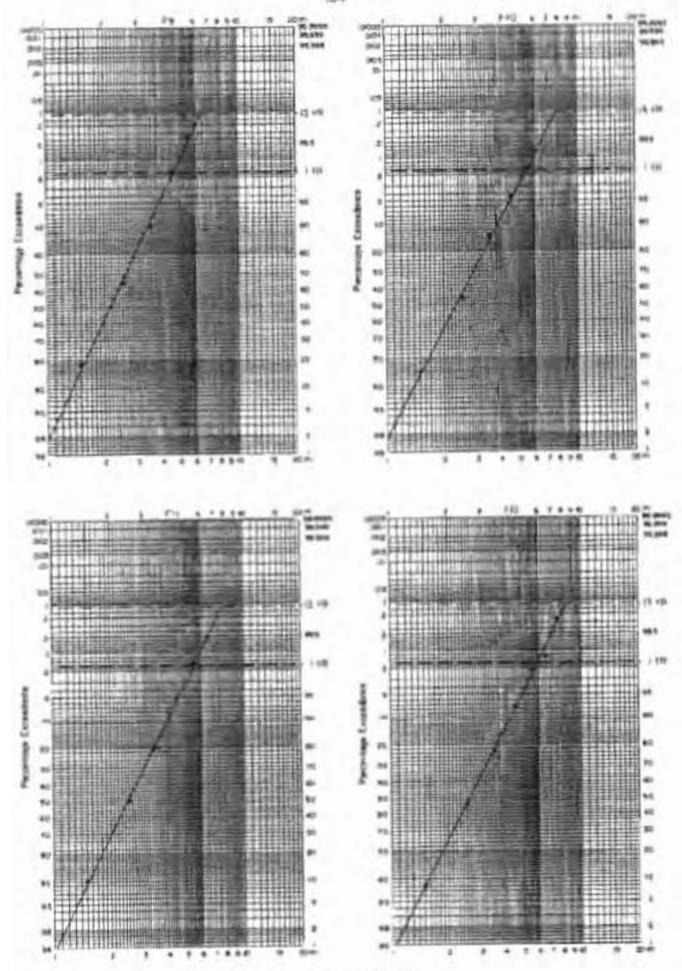


Figure Till Monthly Wave Height Exceedance Dehibuter for July

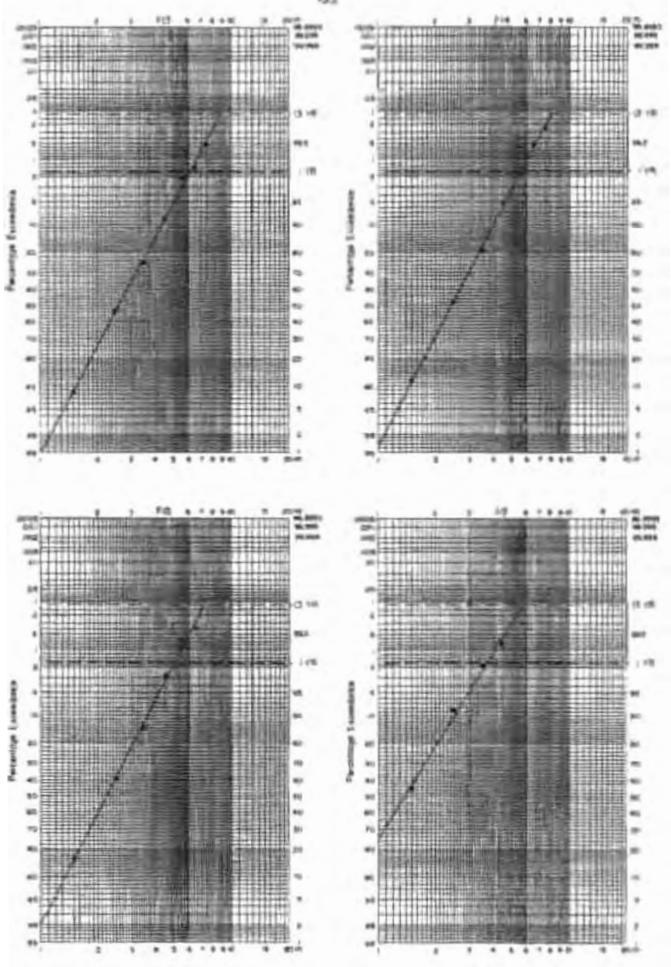
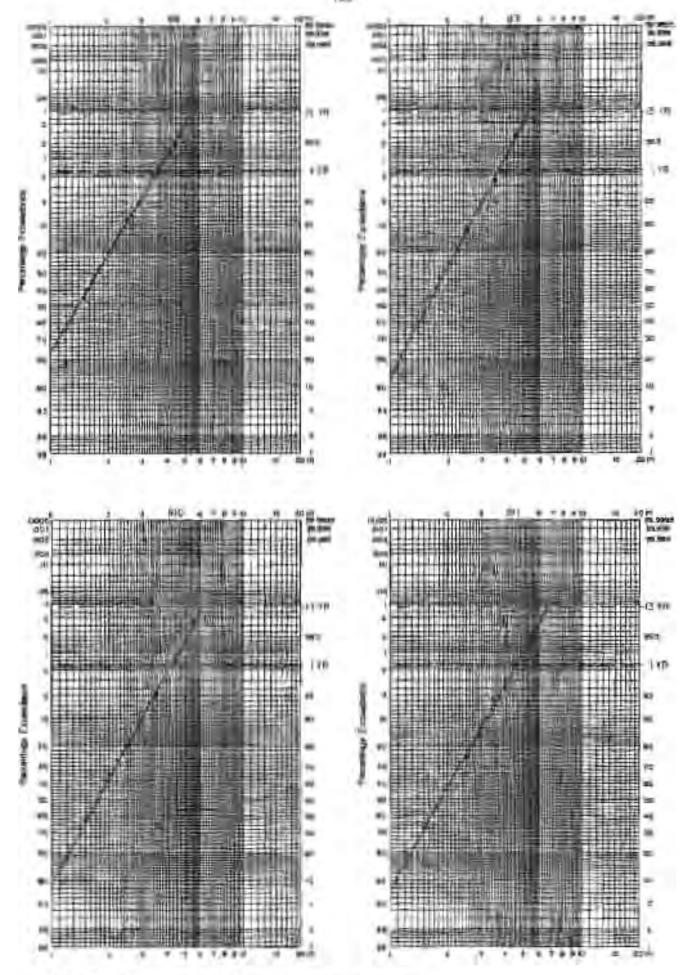
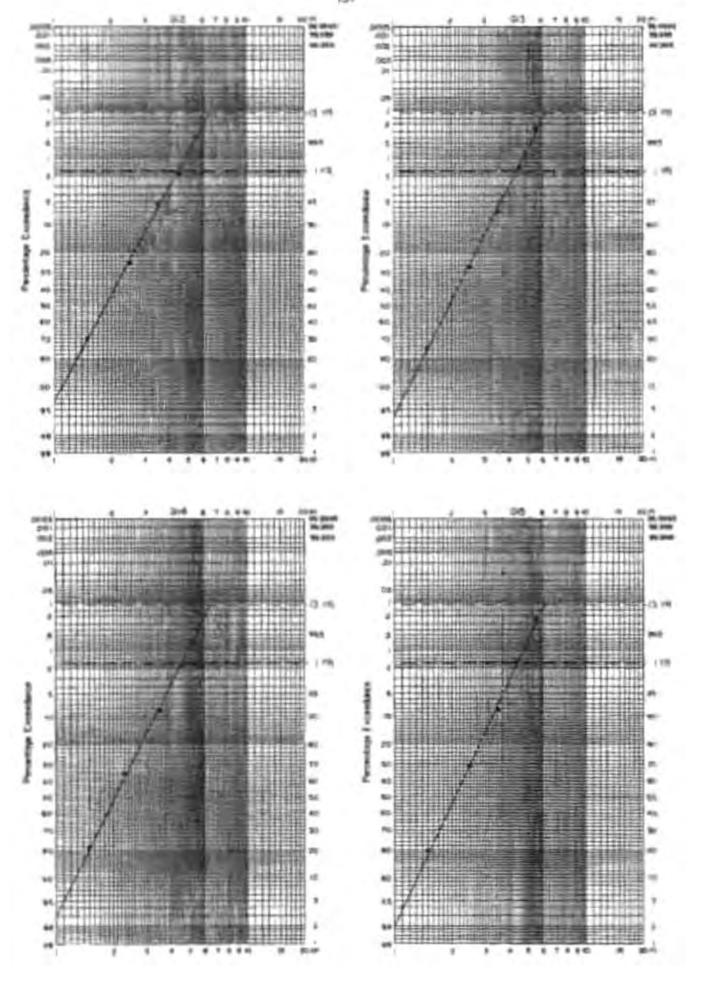


Figure 7



Fepre 7s: Morting Princ Pringle Expenditury Standardon: Inc. Way



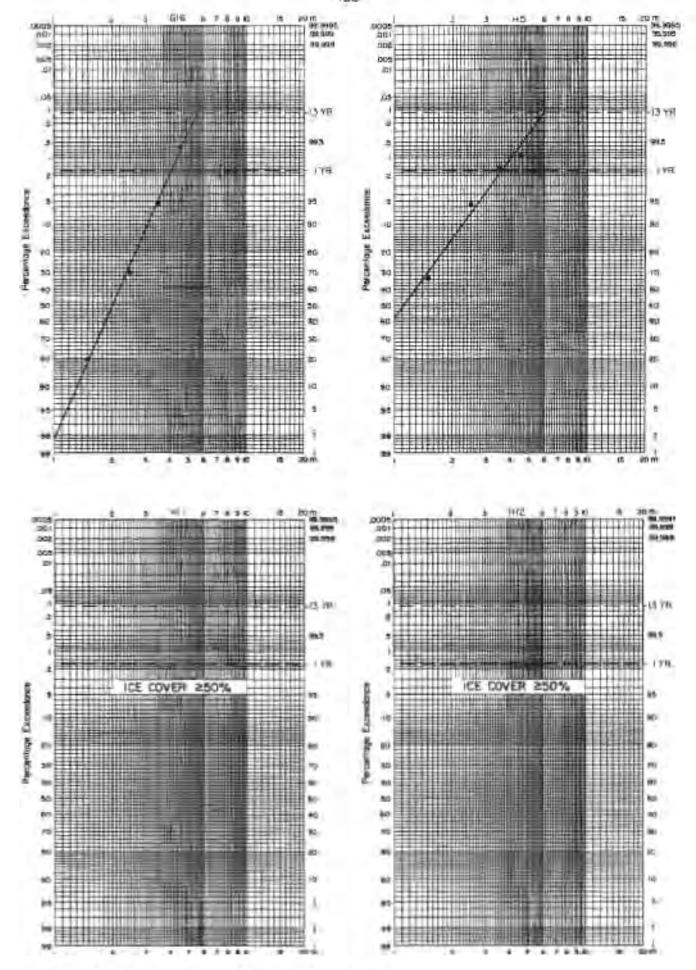


Figure 7s. Monthly Wave Height Extradorce Distribution the July



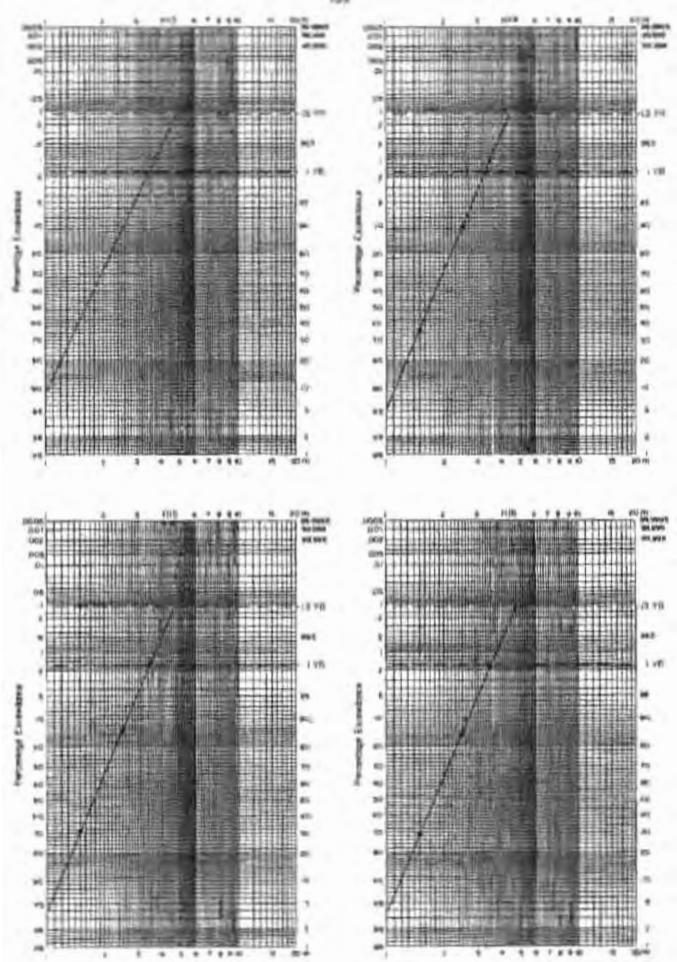


Figure Tv. Moretry Work Height Excentioner (Americanon for July

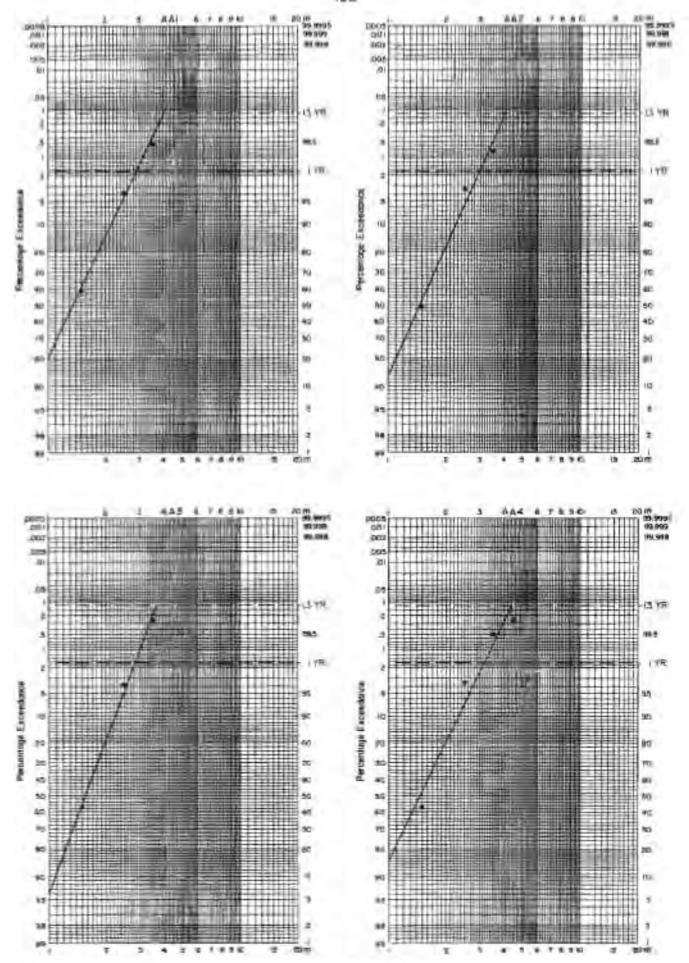
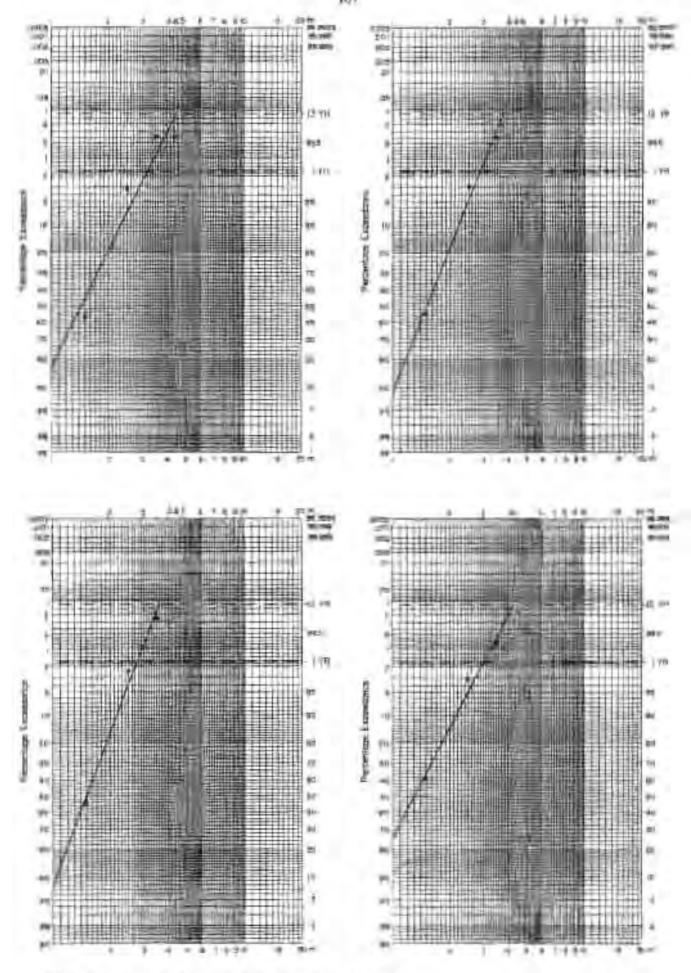
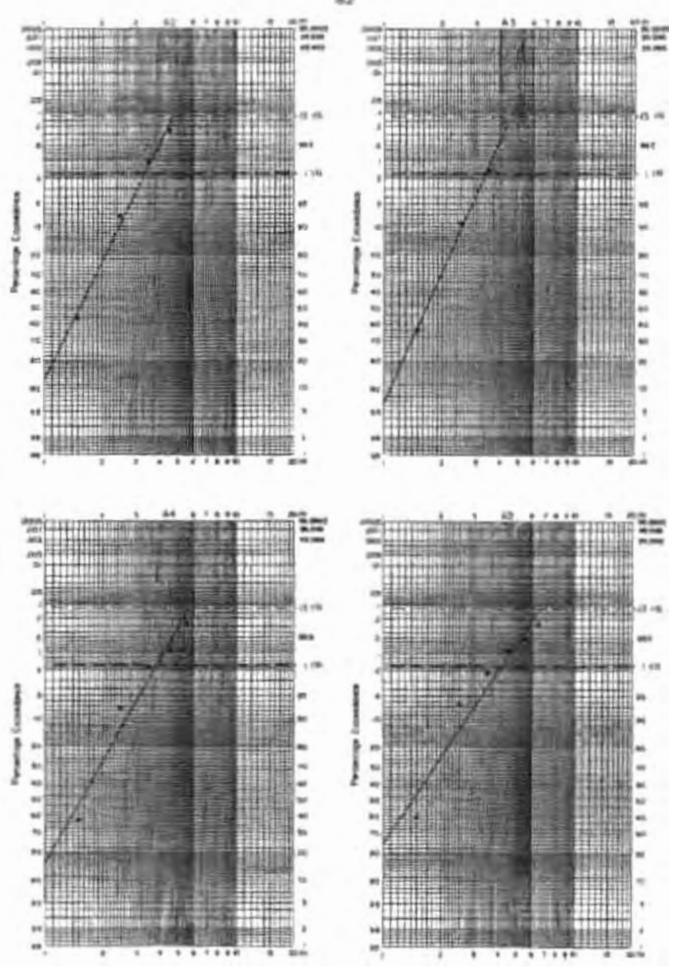
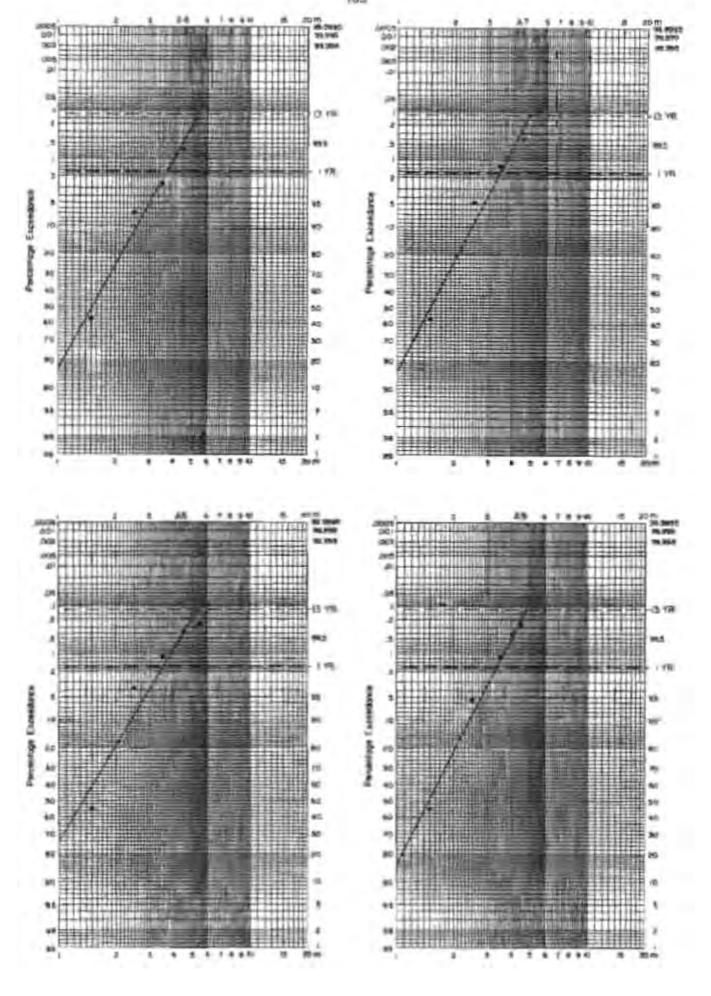


Figure 3c. Monthly Wave Height Excendance Distribulian for Augus!



Tipus its: Minths Work Imply Exceptions Distribution has Reques





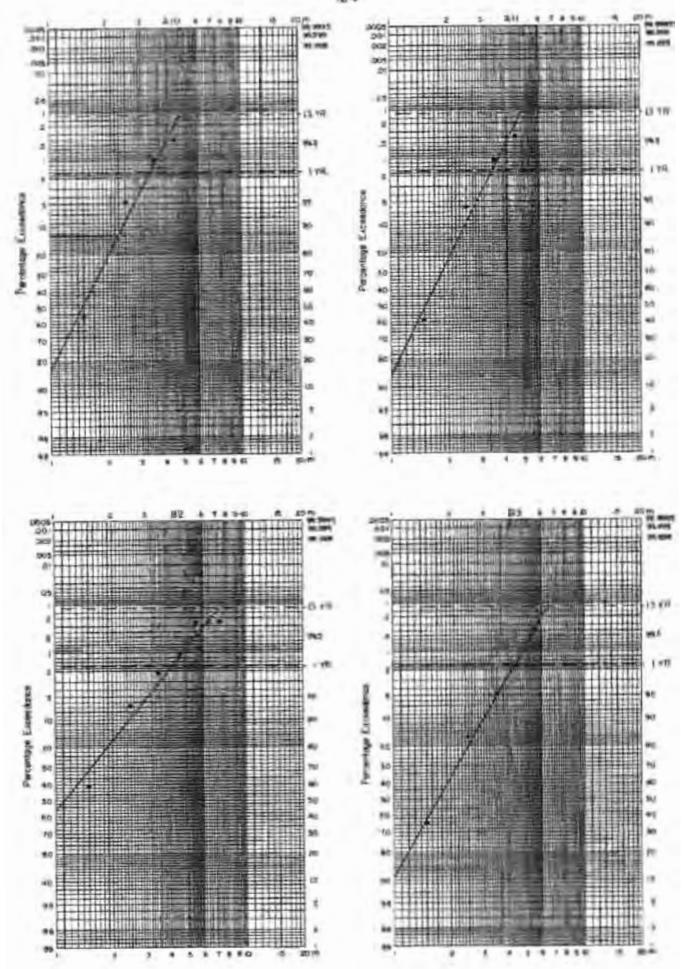
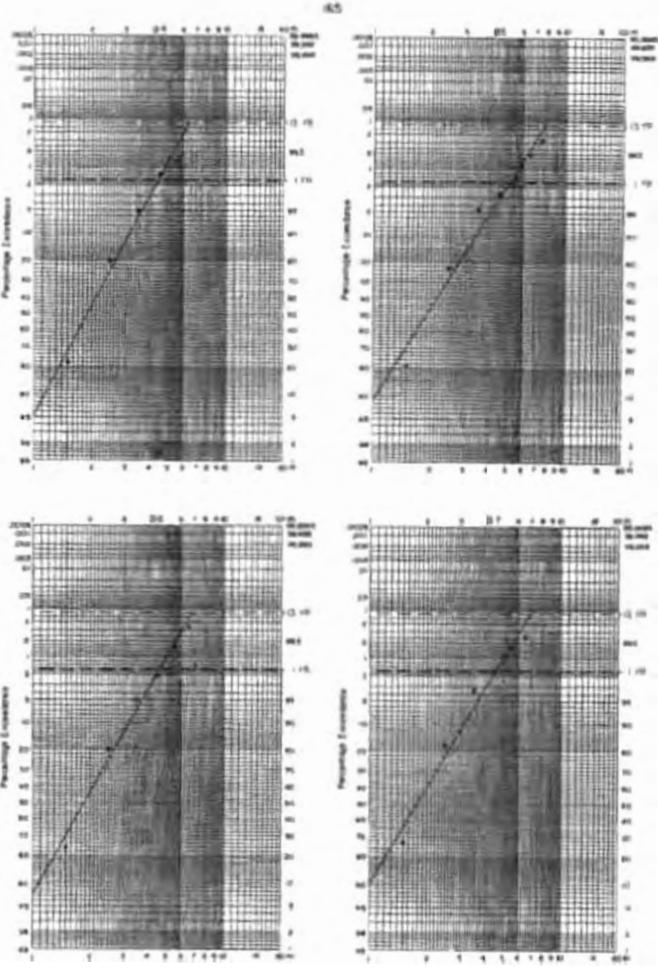
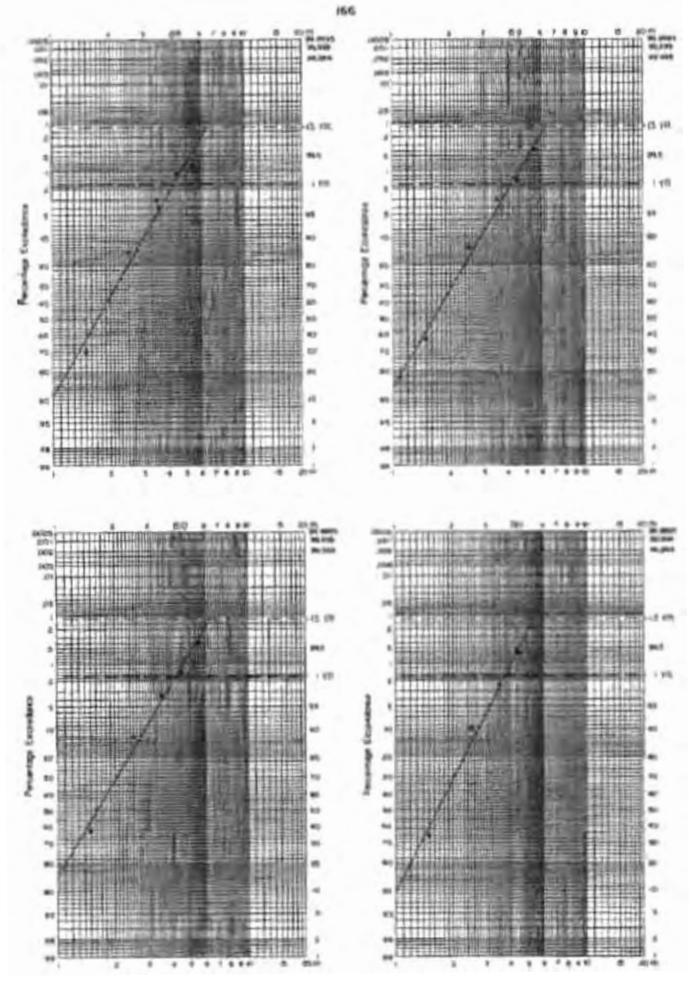


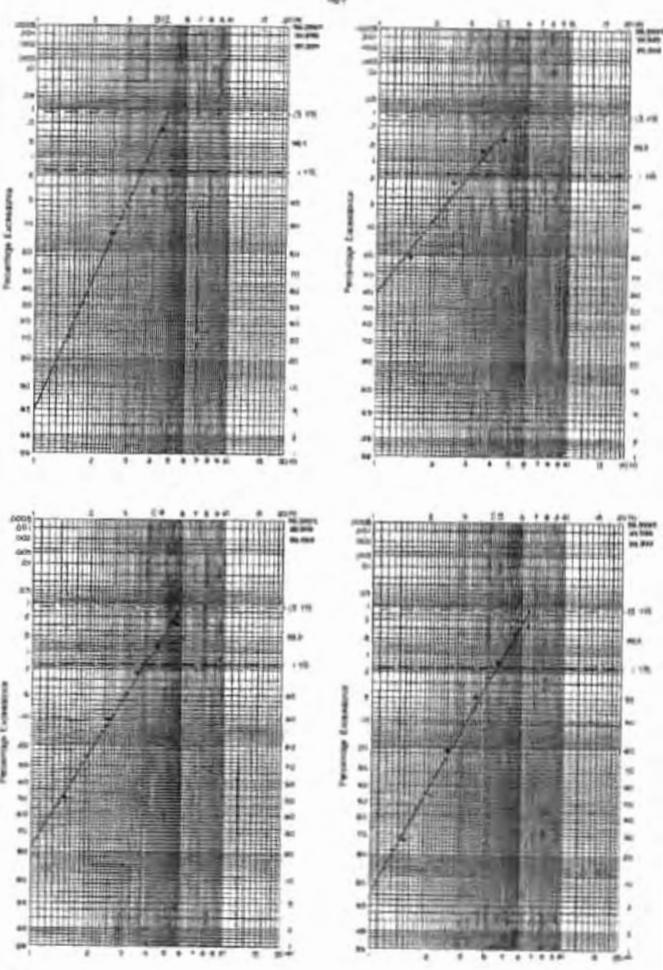
Figure Be. Monthly Wave Height Exceedance Distribution for August











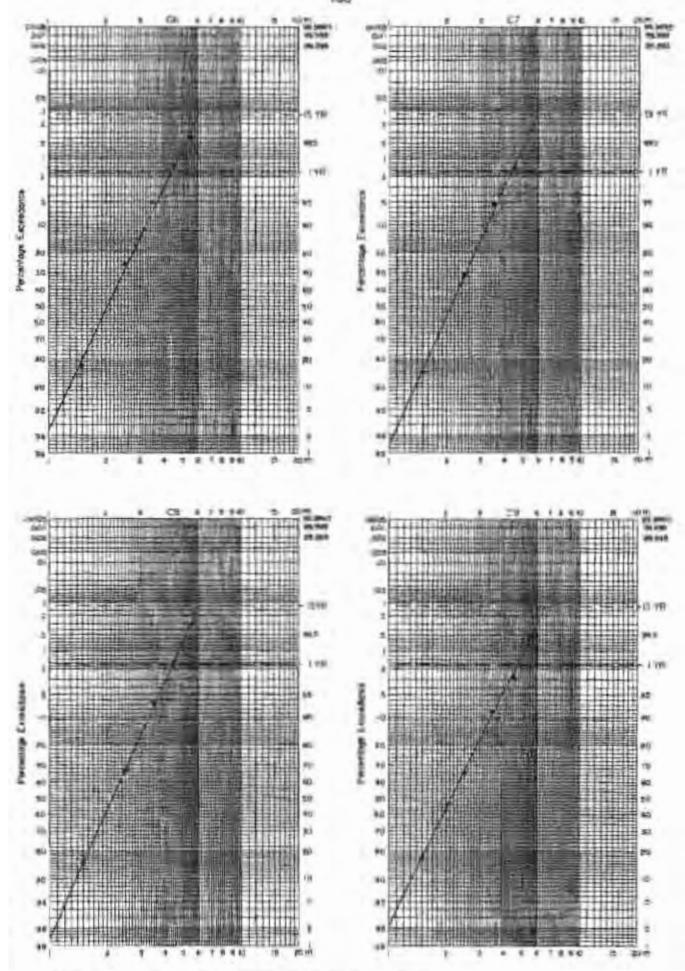
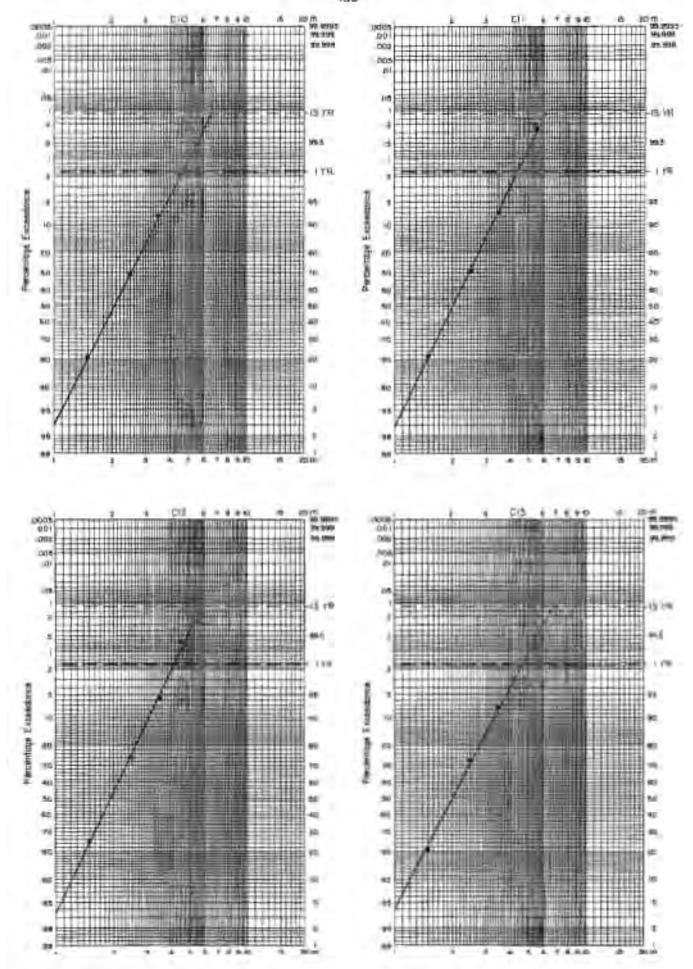
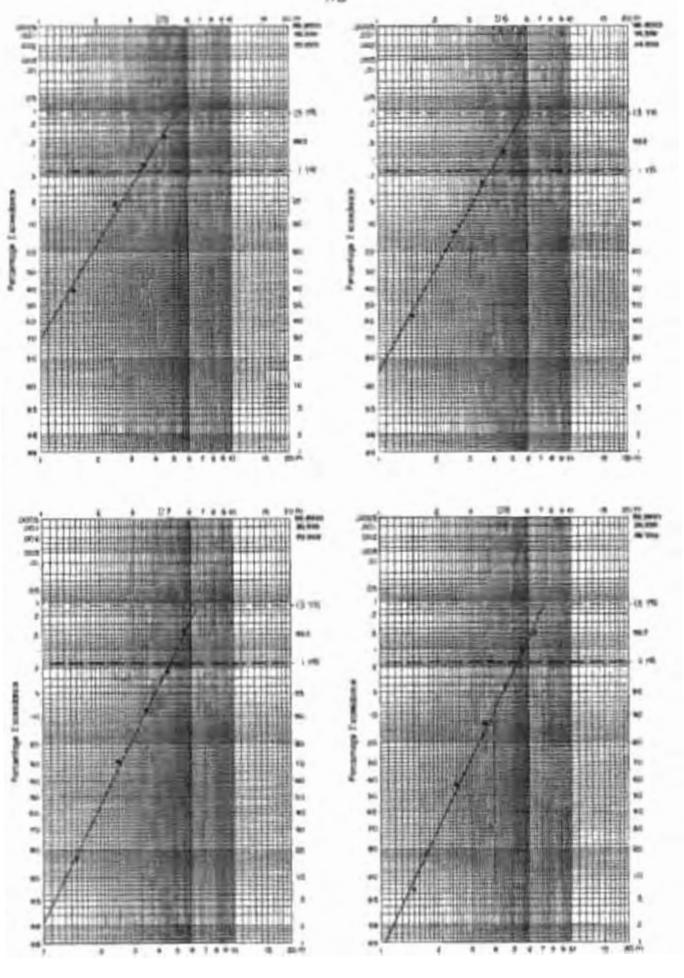


Figure Bi Monthly Wave Heigh! Exceedance Distribution for August



Floure By Monthly Work Height Exceedance Distribution for August





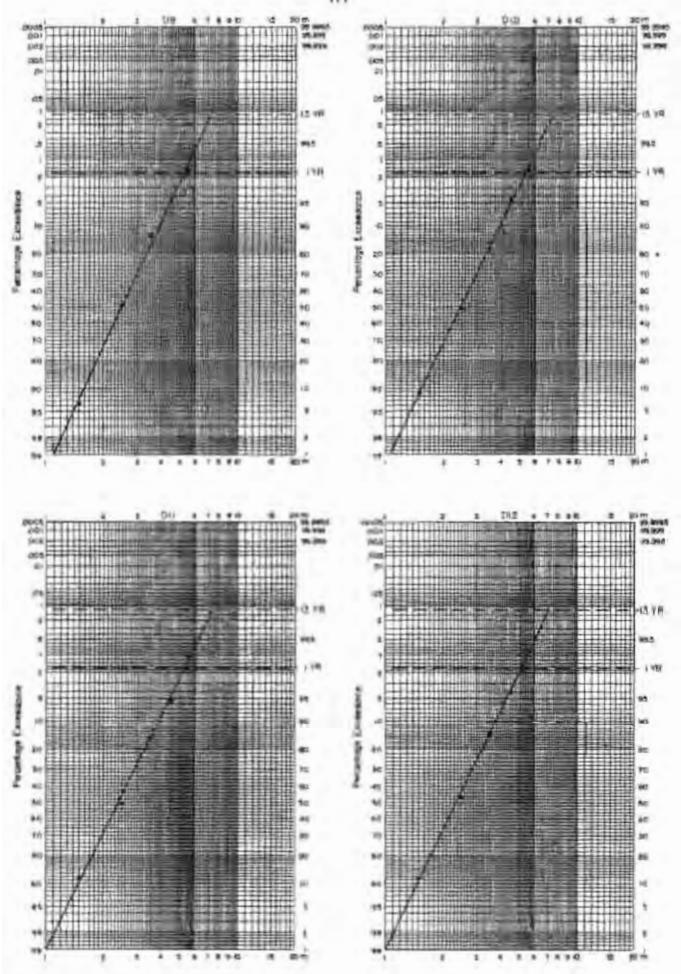
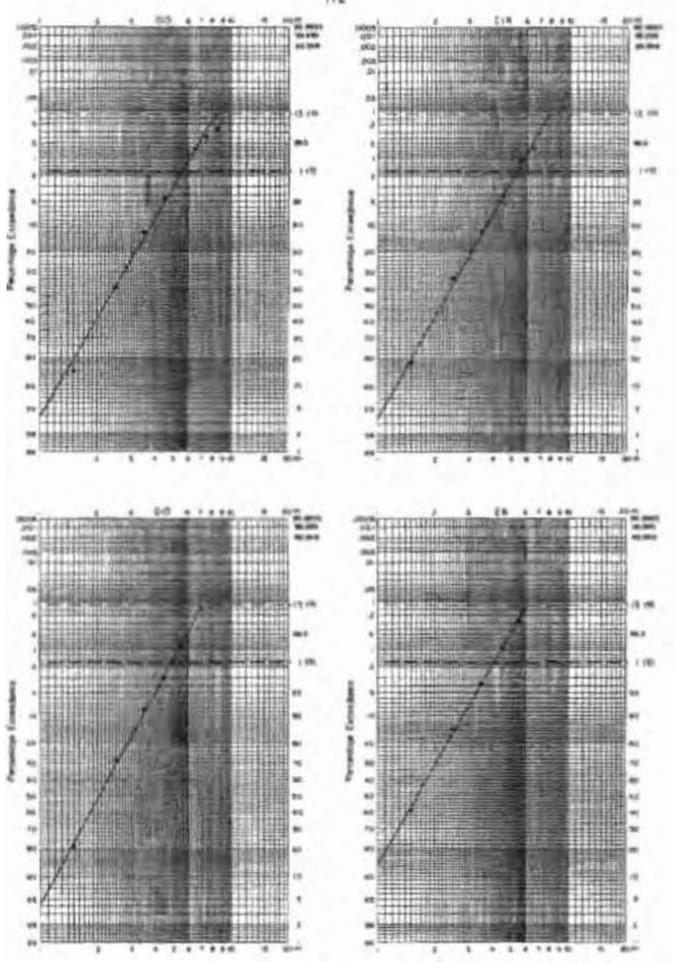


Figure 81 Monthly Wave Height Excentance Destribution No. August.



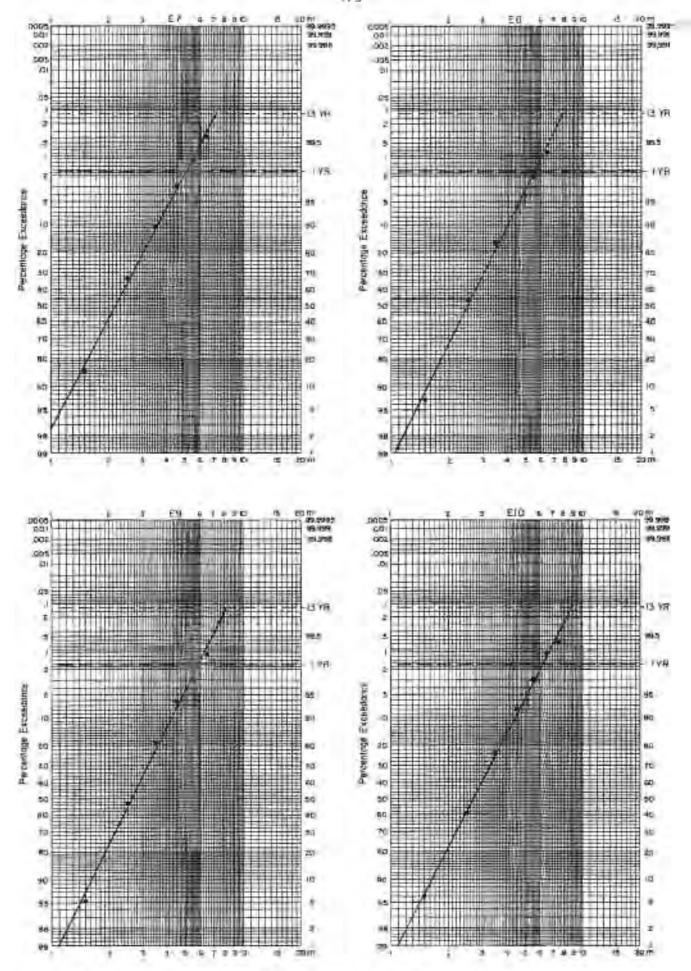
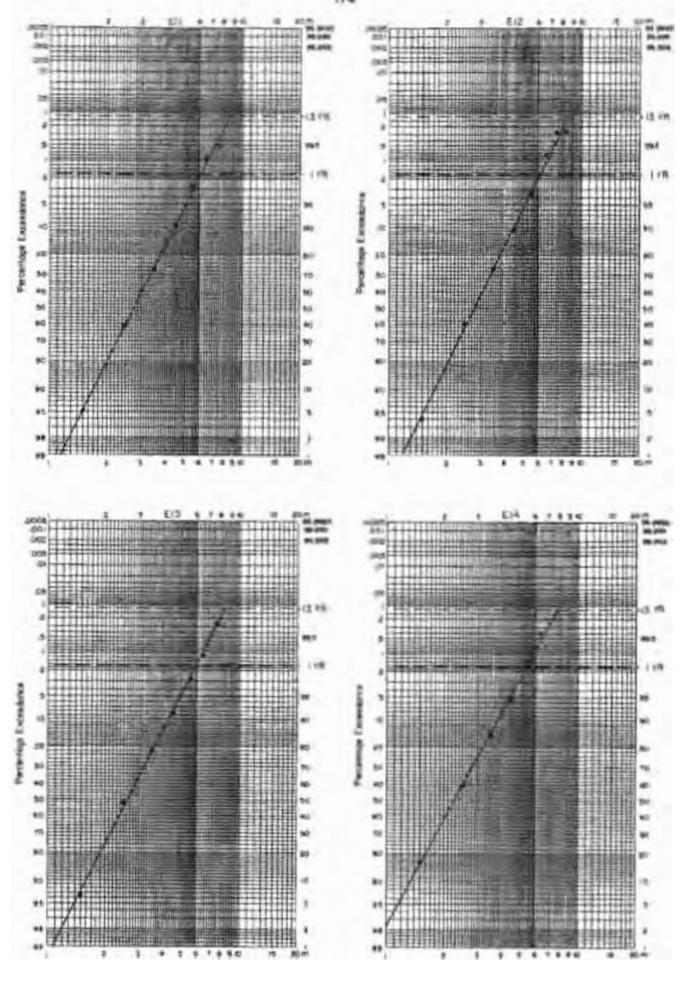


Figure Rin. Monthly Wave regist Exceedance Distribution for August



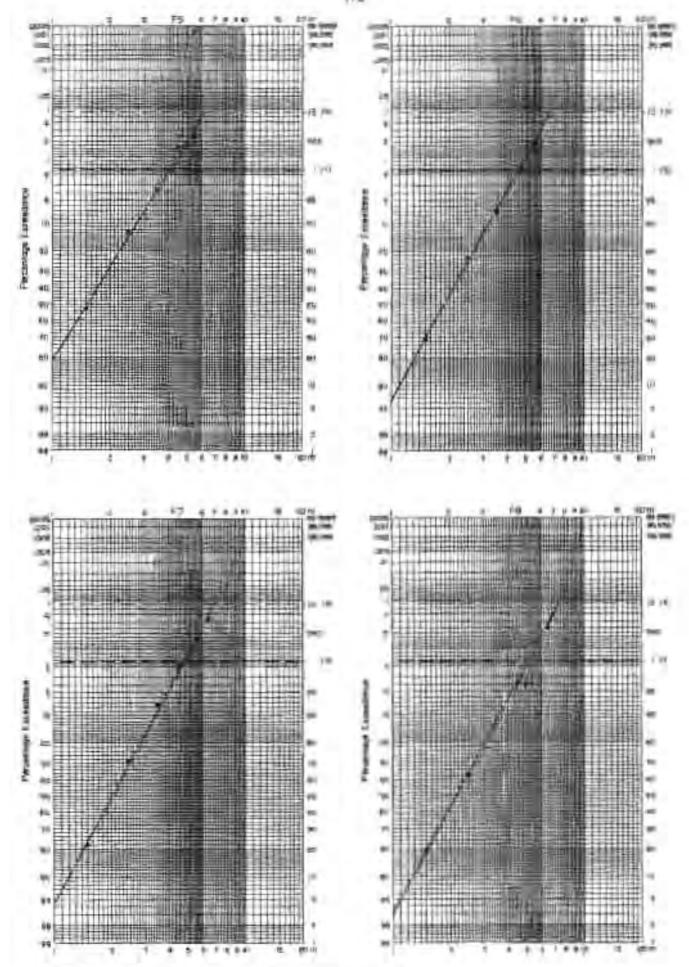
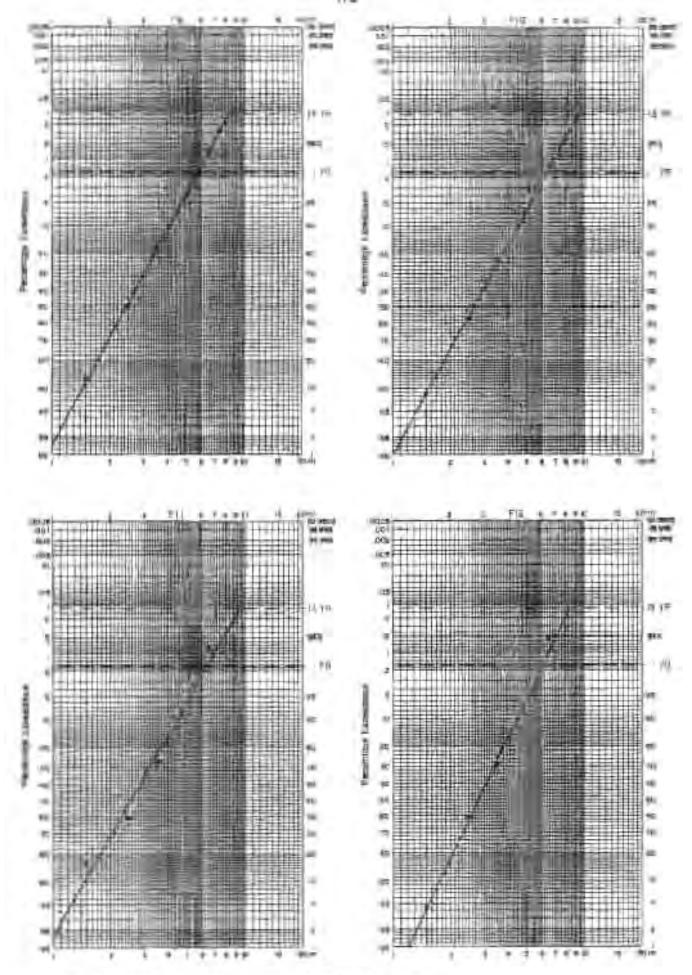


Figure Got Monthly Wave Hargh? Excheditives Distribution for August.



Trapes dis Marittà Moss Auges Excessores Frontaction file August

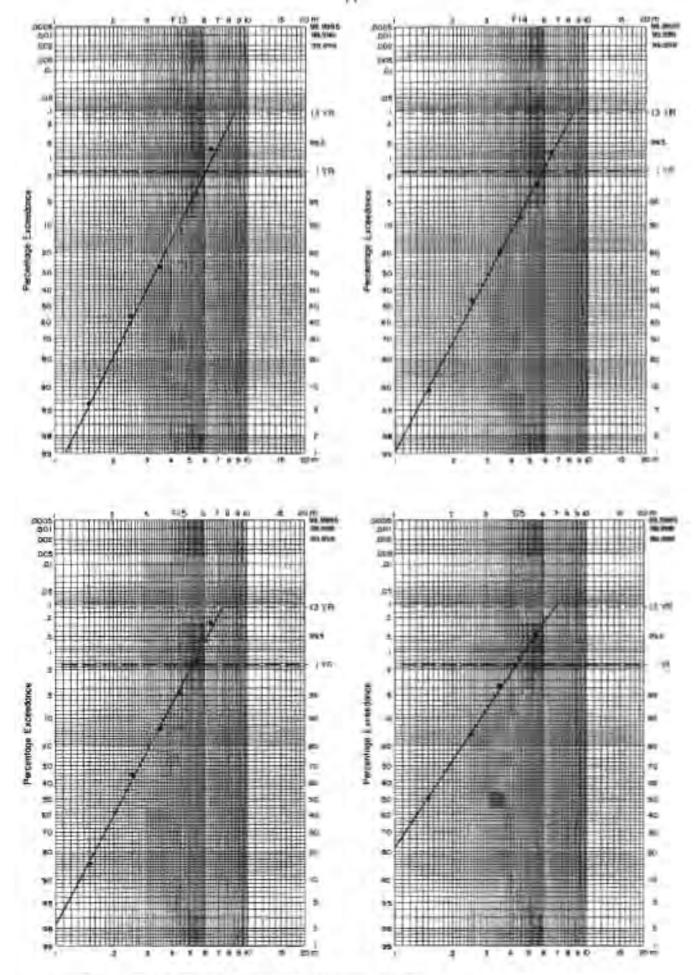
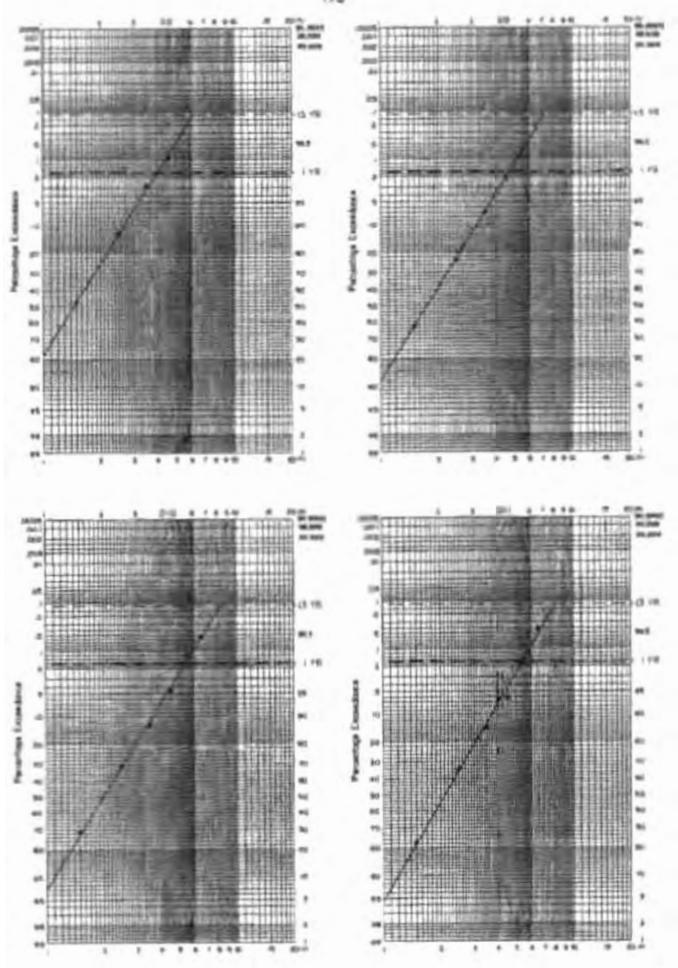
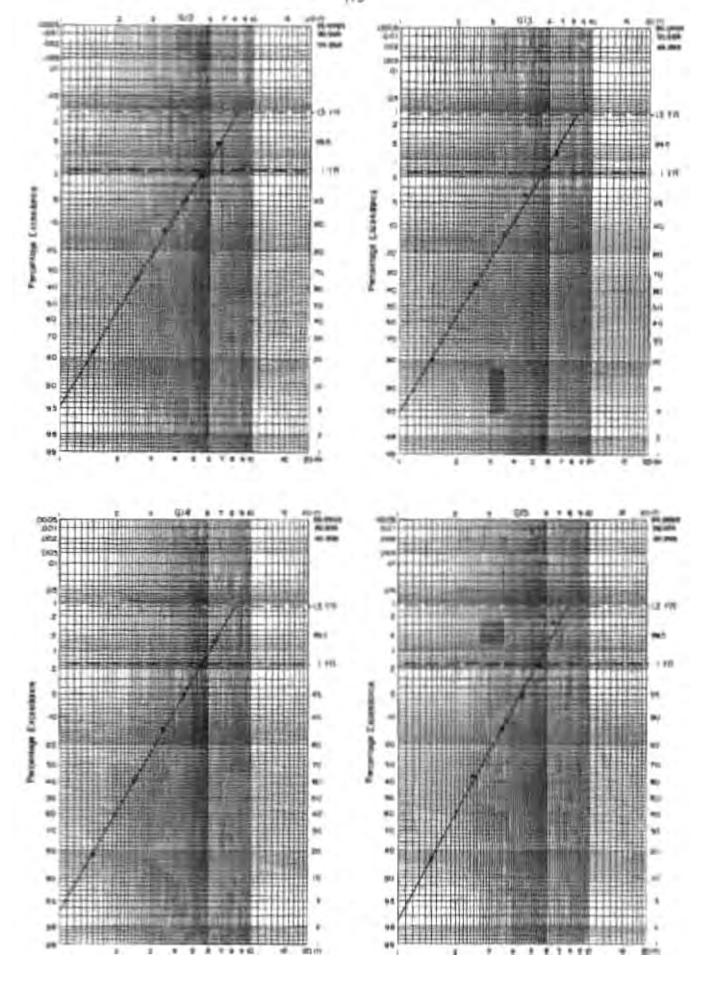


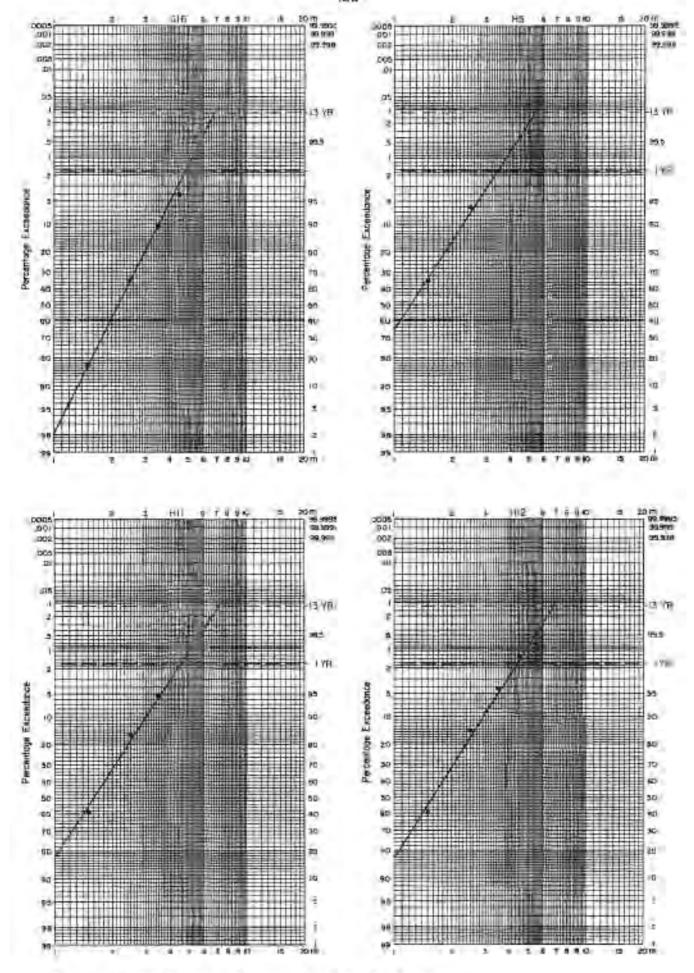
Figure Br Monthly Wave Height Exceedance Distribution in August



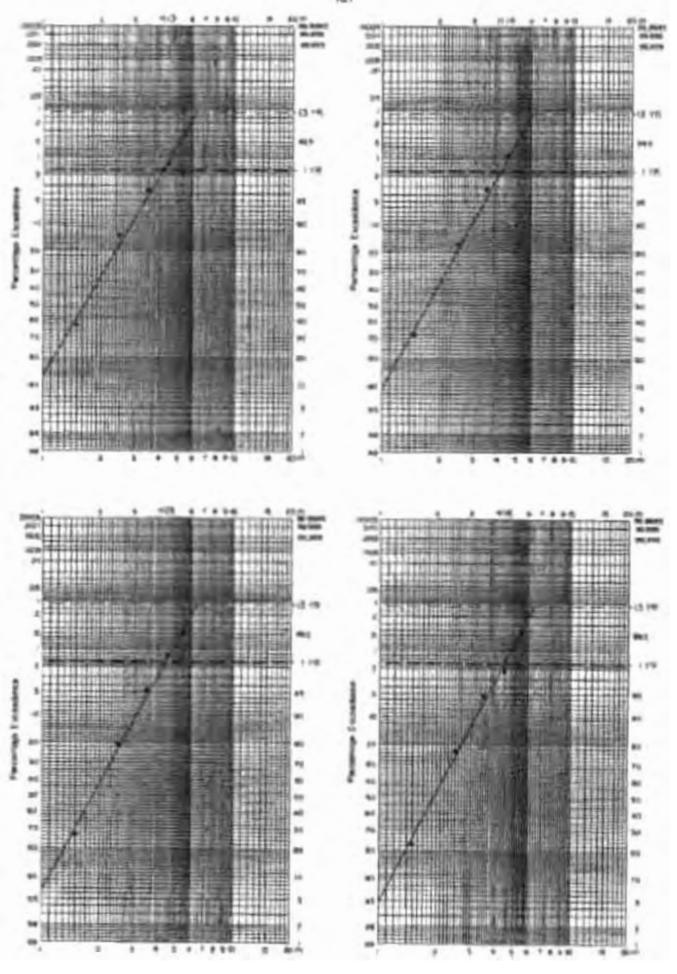


Fapre Da.





Flaure Bu. Monthly Wave Irelight Exceedance Distribution for August



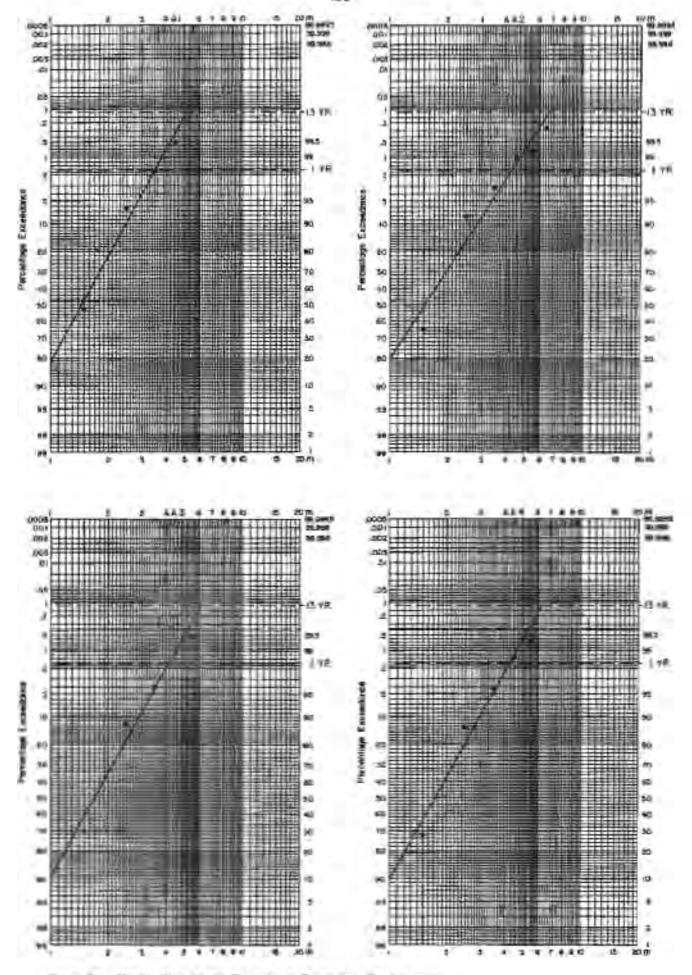


Figure St. Monthly Wave Height Excelledance Distribution for September

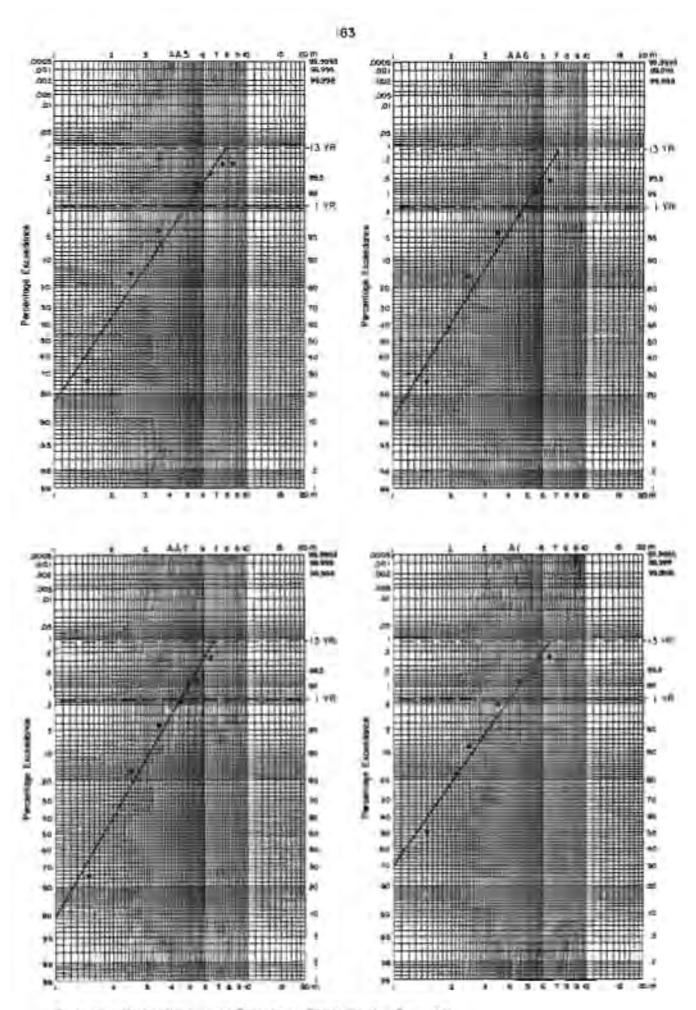


Figure 36 Monthly Wave Height Excendence Distribution for September

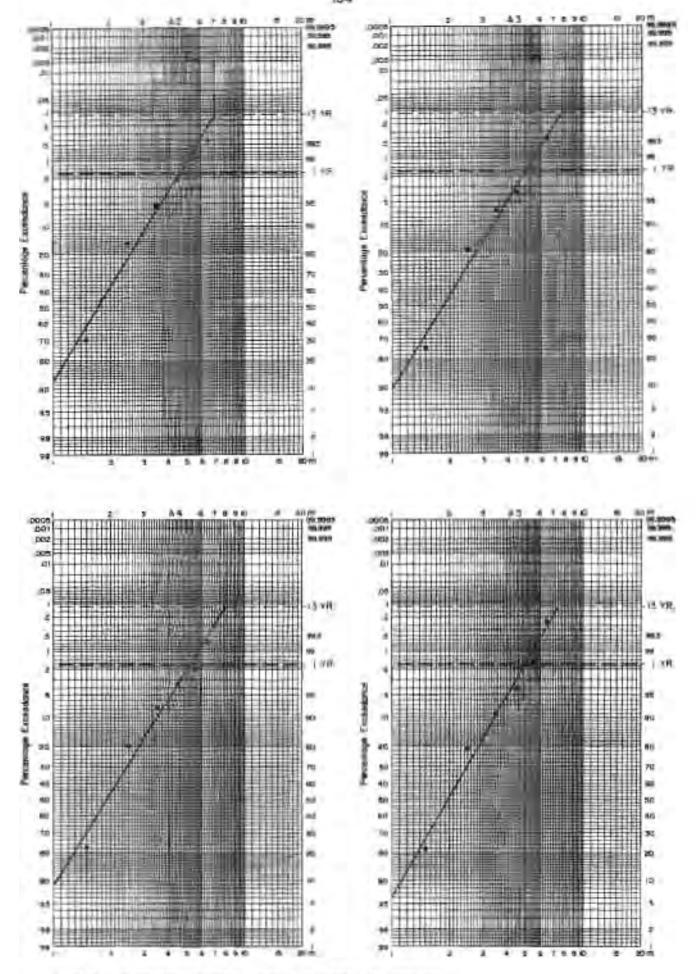


Figure St. Monthly Wine Height Exceedures Distribution for September

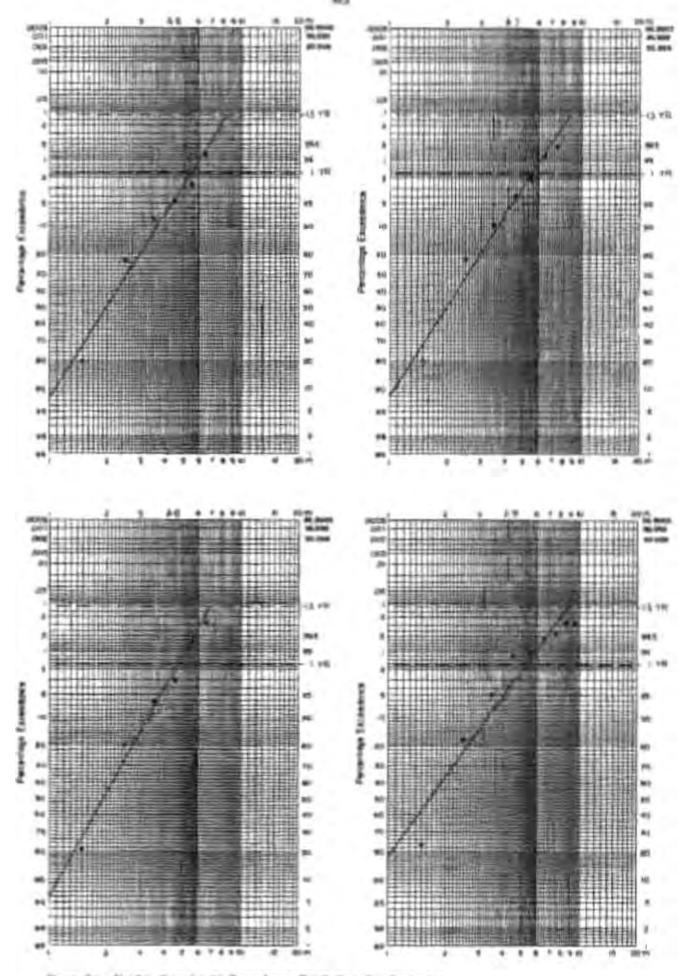


Figure Sci. Monthly West Felight Excendence Detribution for Depletoker

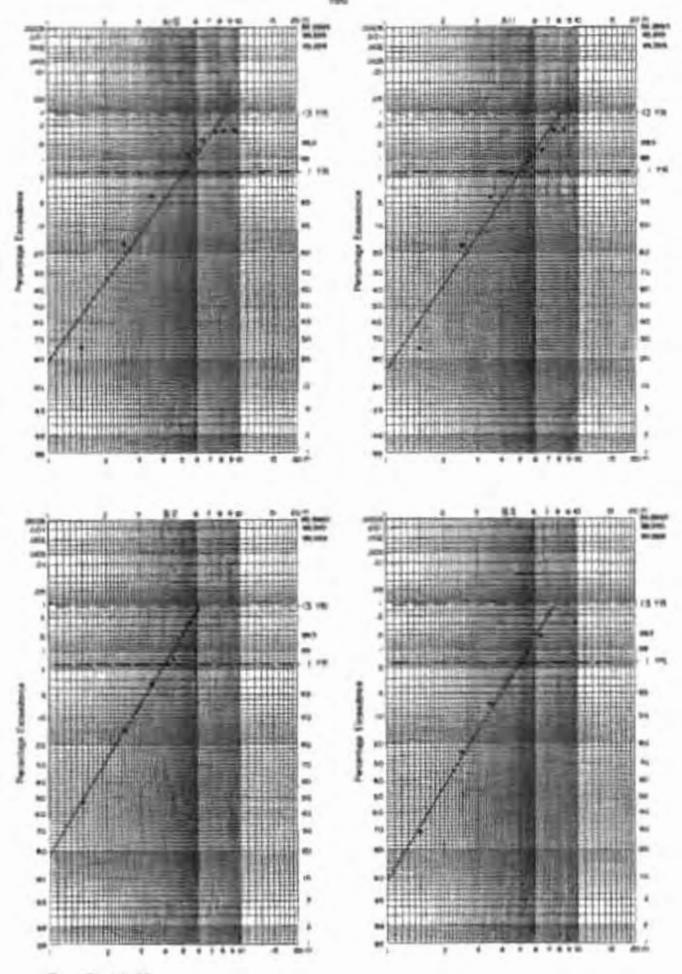


Figure Str. Monthly

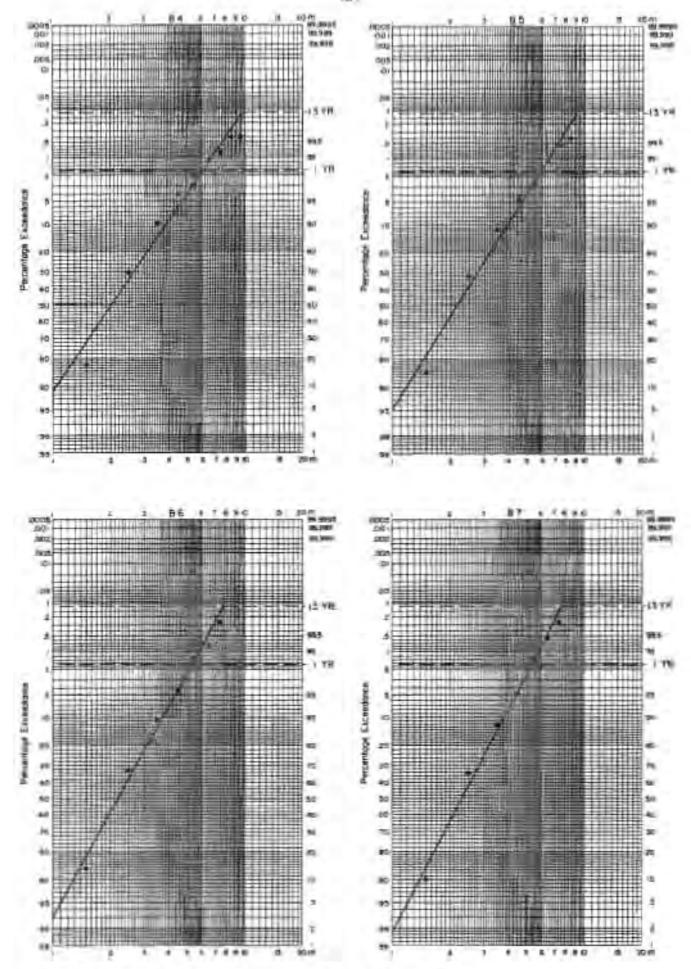


Figure 31 Months wave marghi Exceedance Distribution for September

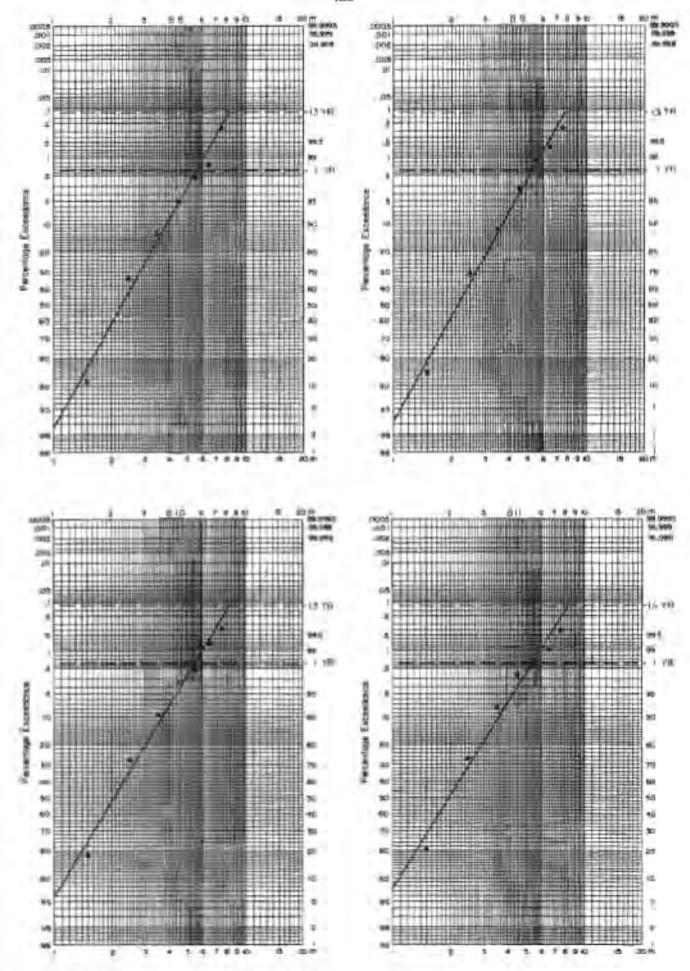
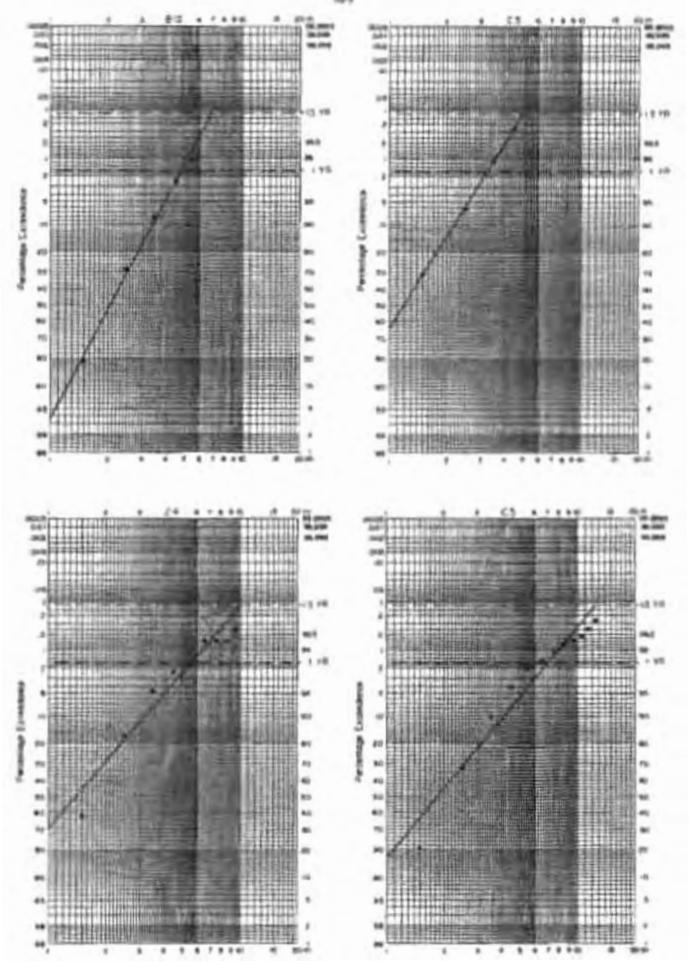


Figure 9g. Monthly Wave Height Exceedance Distribution for September



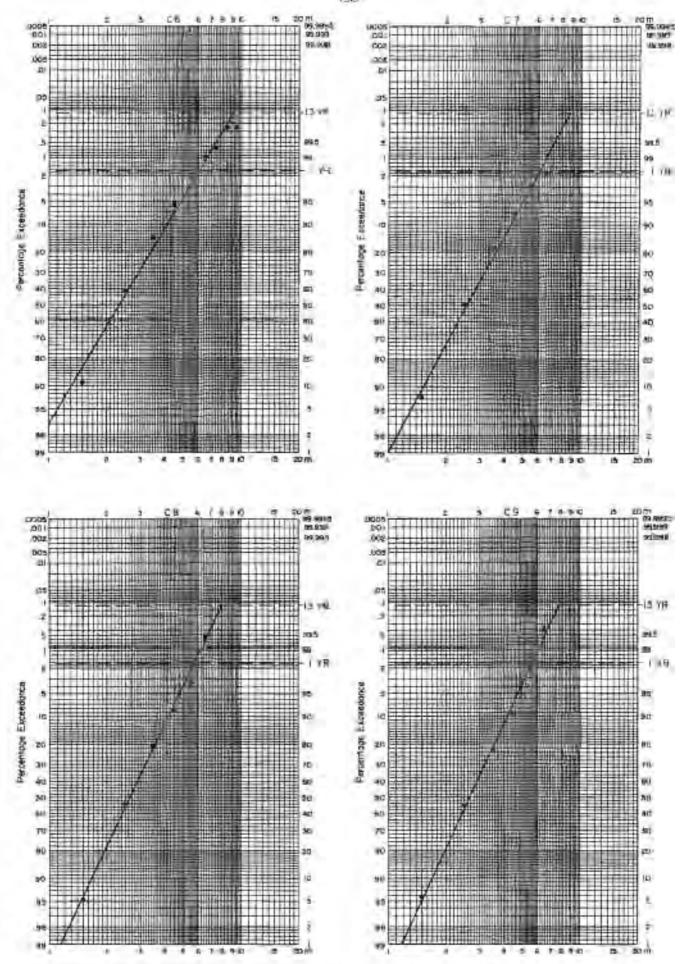
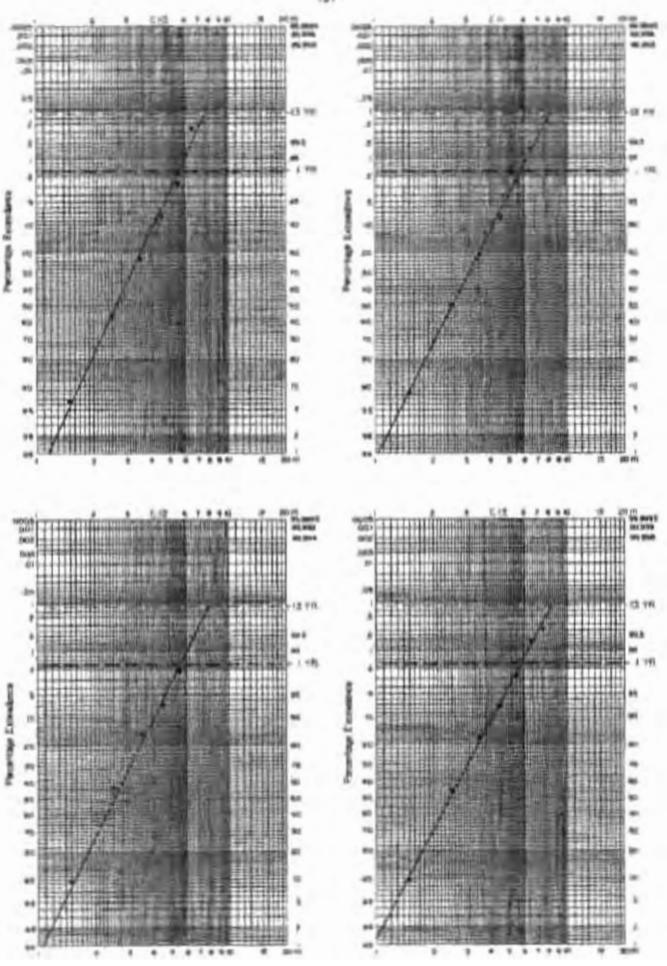


Figure 9) Monthly Work Fields Exceedance Instribution to September



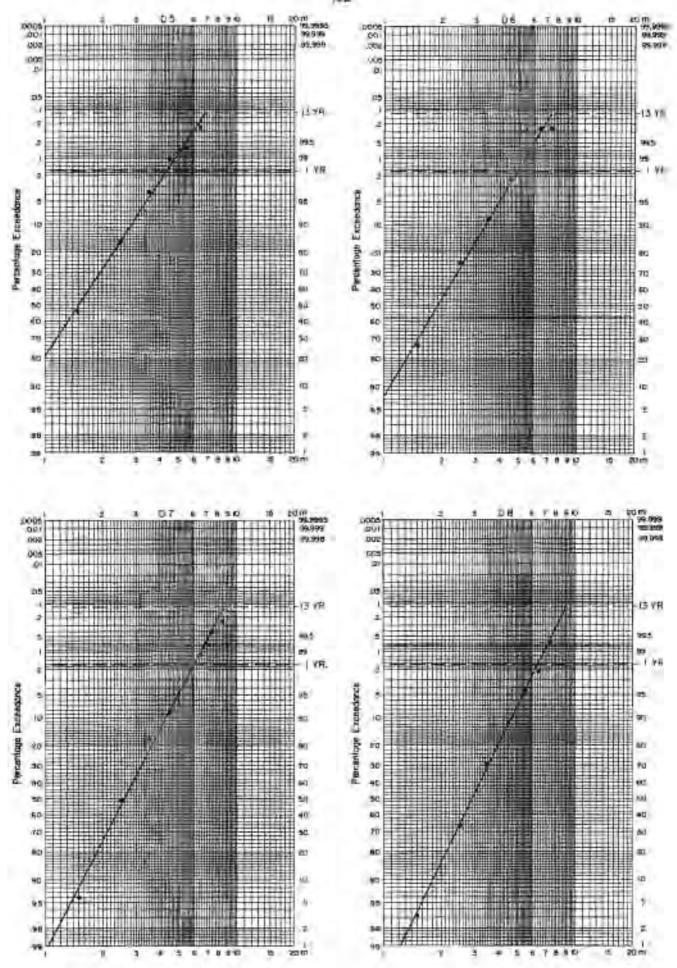


Figure 94: Monthly Wave Height Exceedance Distribution for September

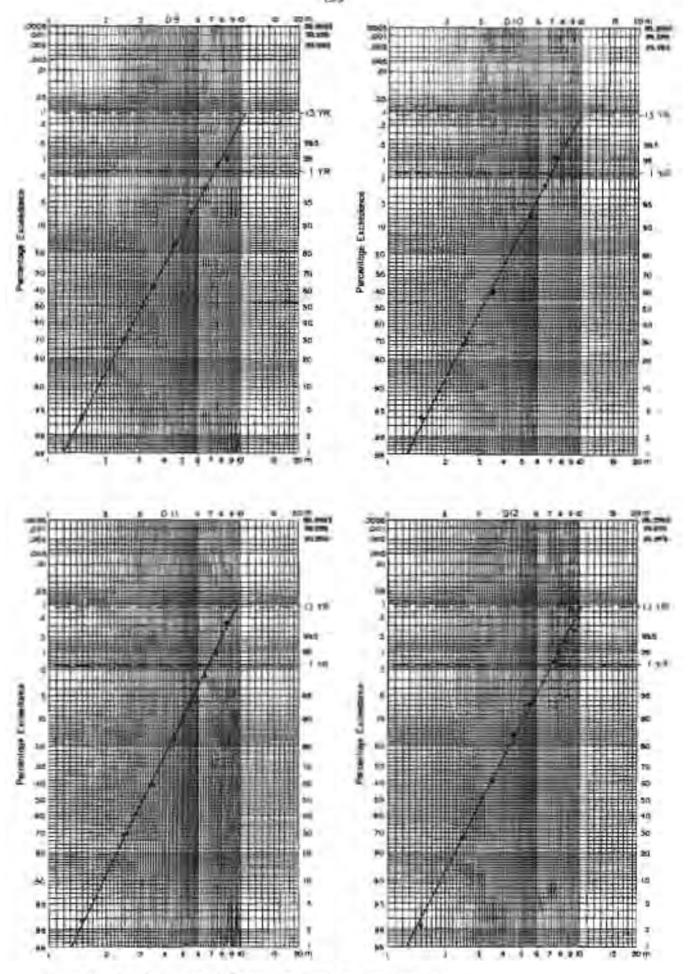


Figure 31. Monthly Ways height Excendence Distribution for Systember

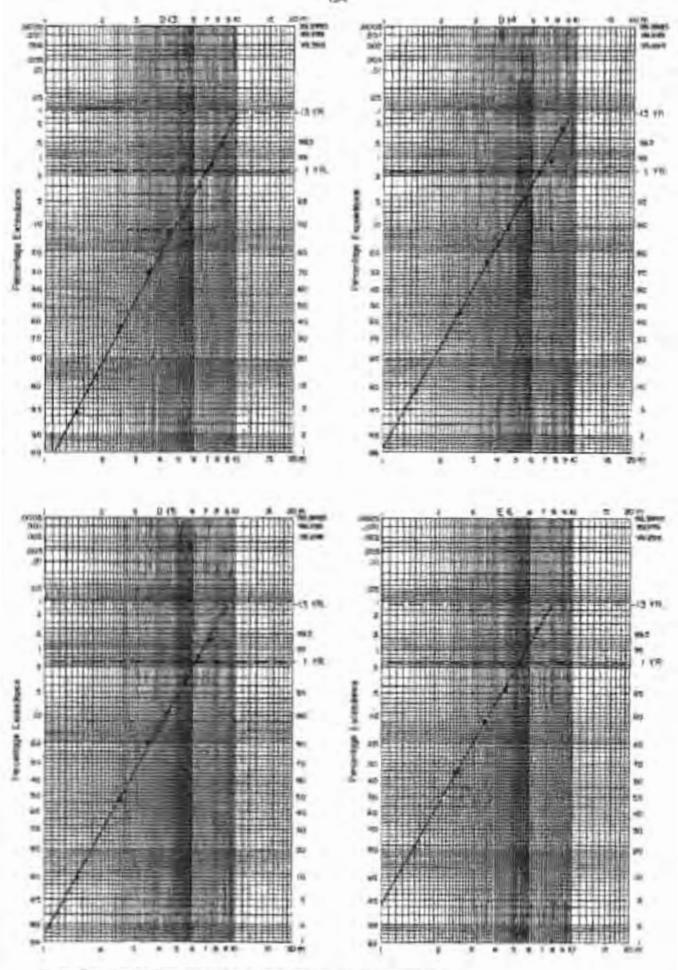
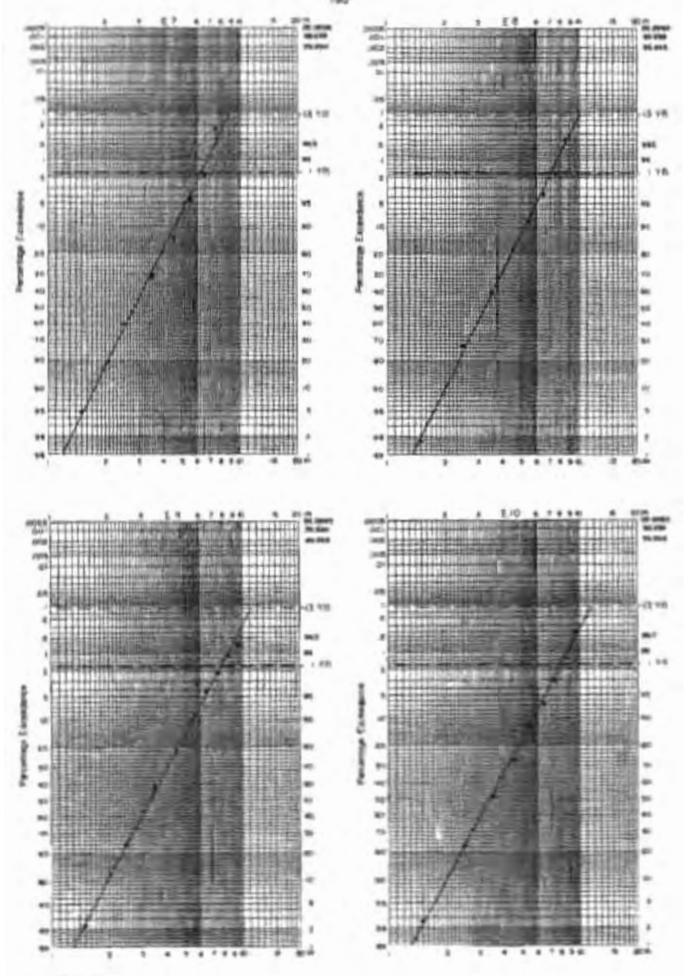


Figure Sim. Moviny little Height Eurandonica Distribution for September





Figer Br

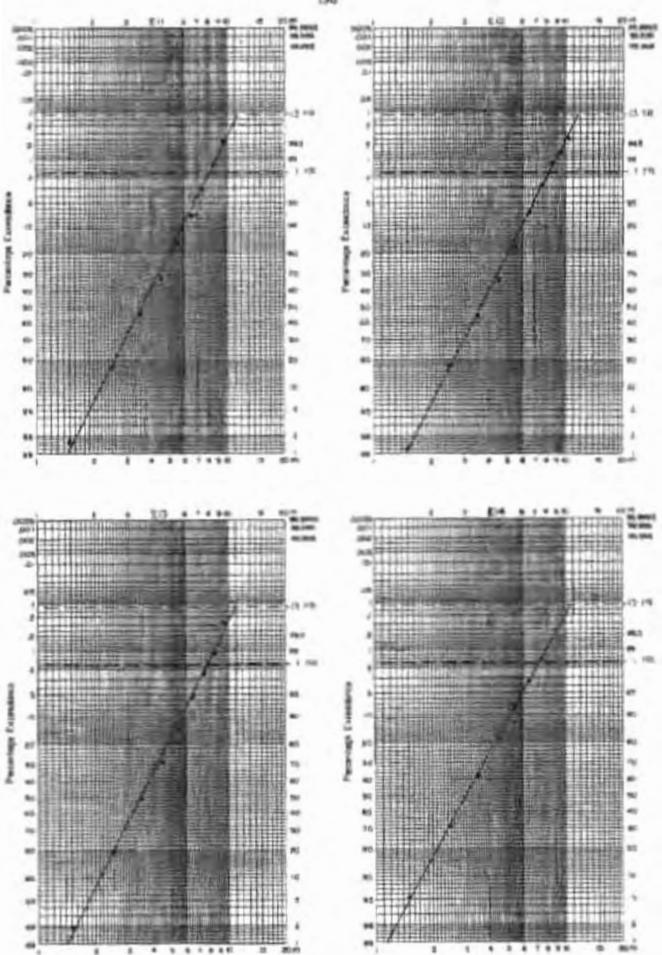


Figure Ws. Monthly Wove range? Exceedurce Distribution for September

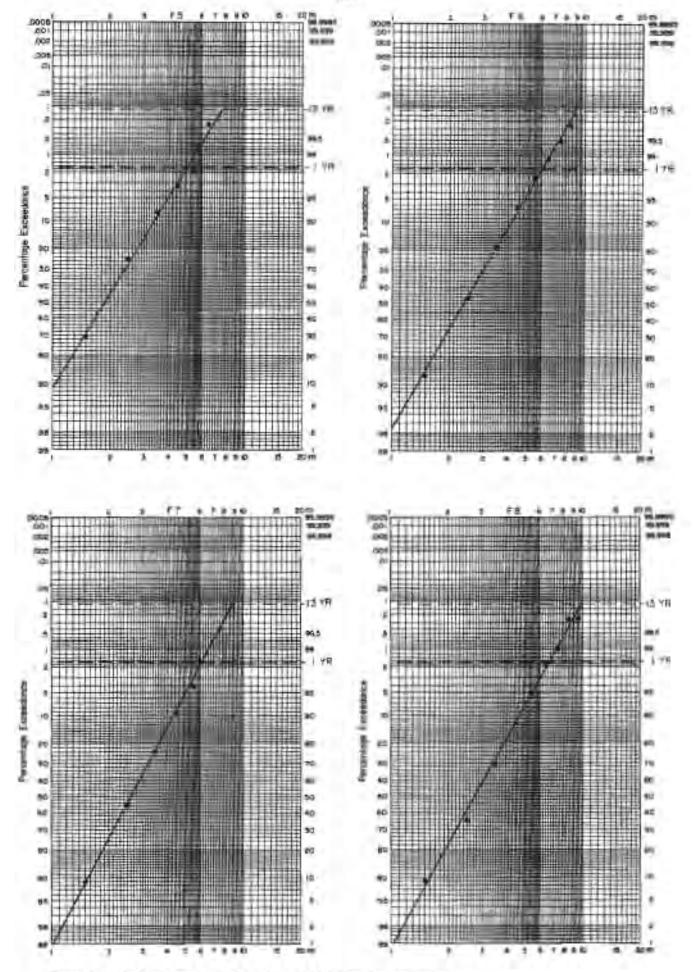


Figure Sp. Moethly Wove resign Excendence Distribution for September

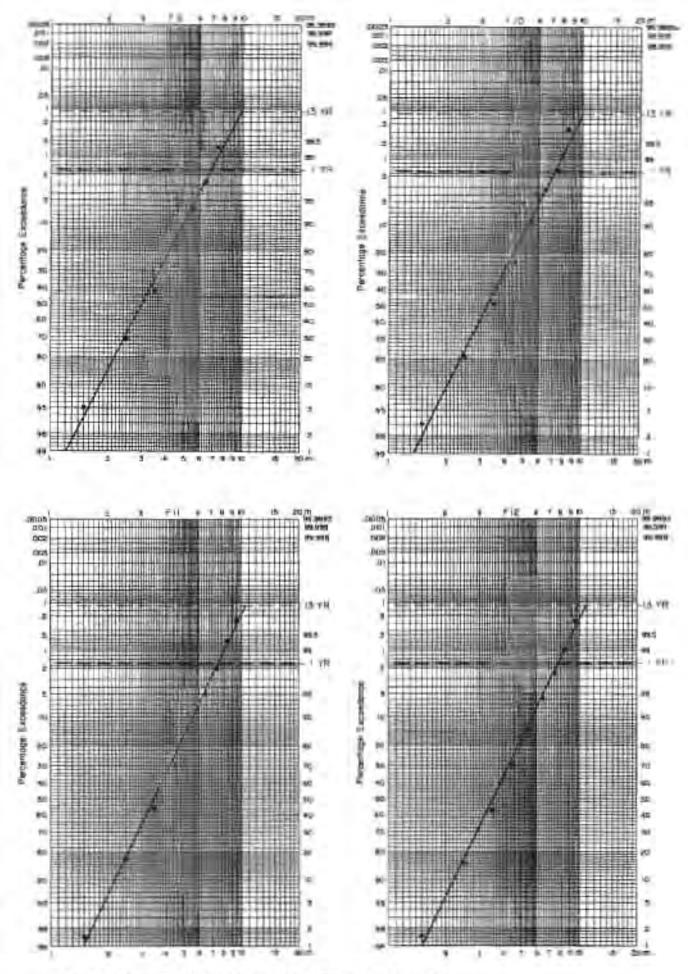


Figure Its: Monthly Rose Height Exceedance Statebullor for September

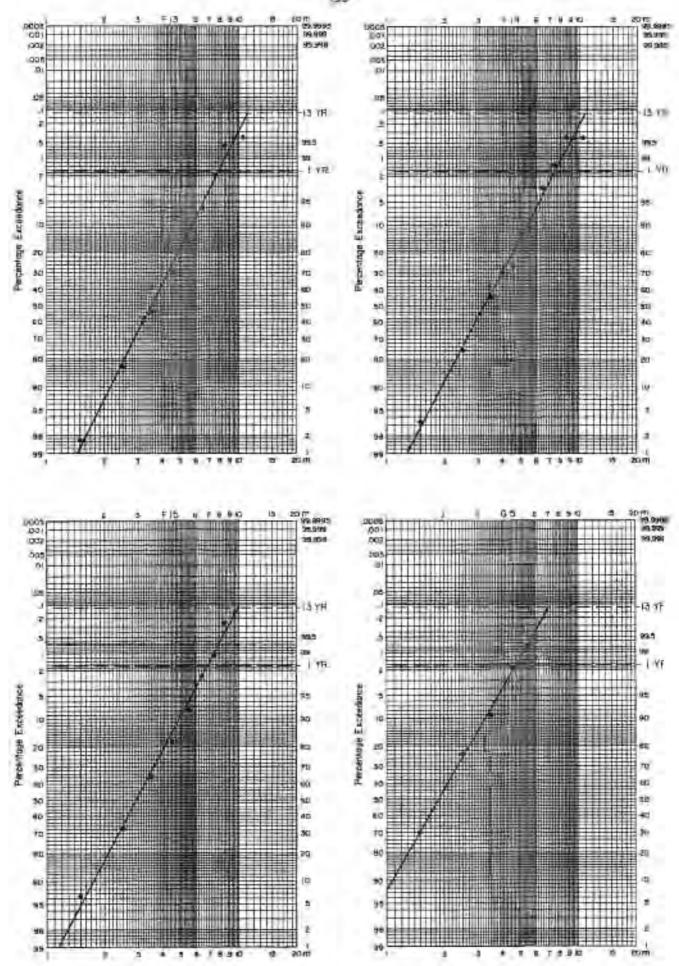


Figure 3: Monthly Wave Height Exceedance Distribution for September

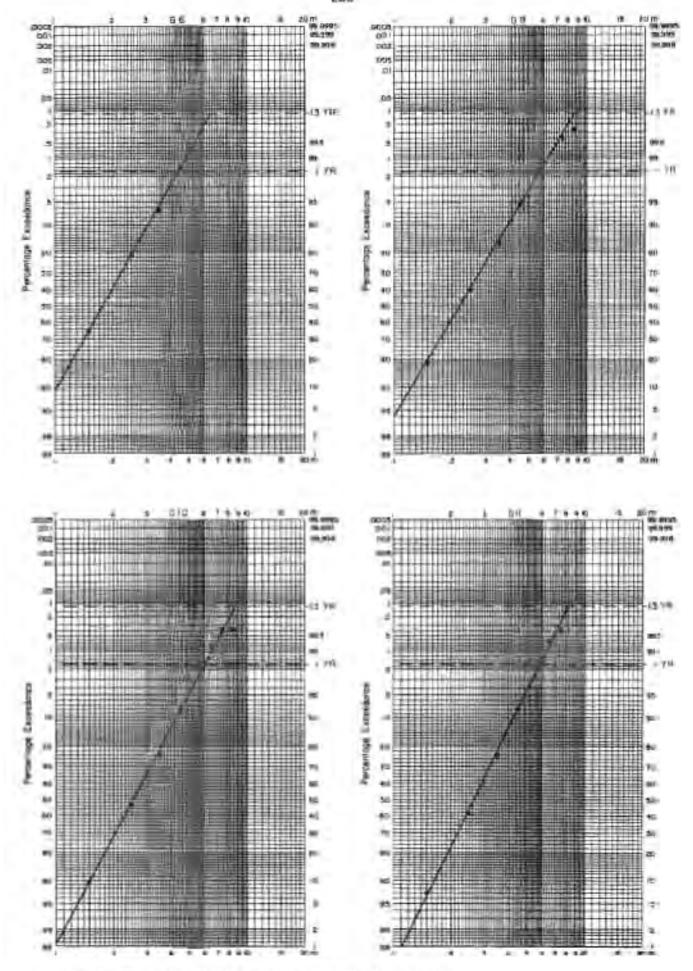
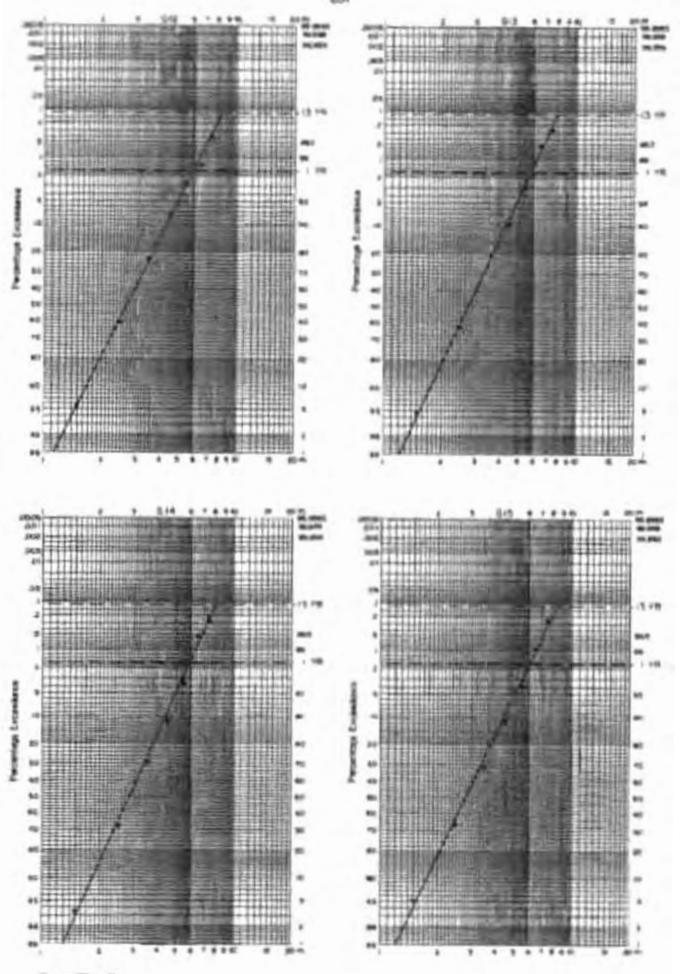


Figure 9s. Monthly World Height Exceedance Distribution for September





Egre III N

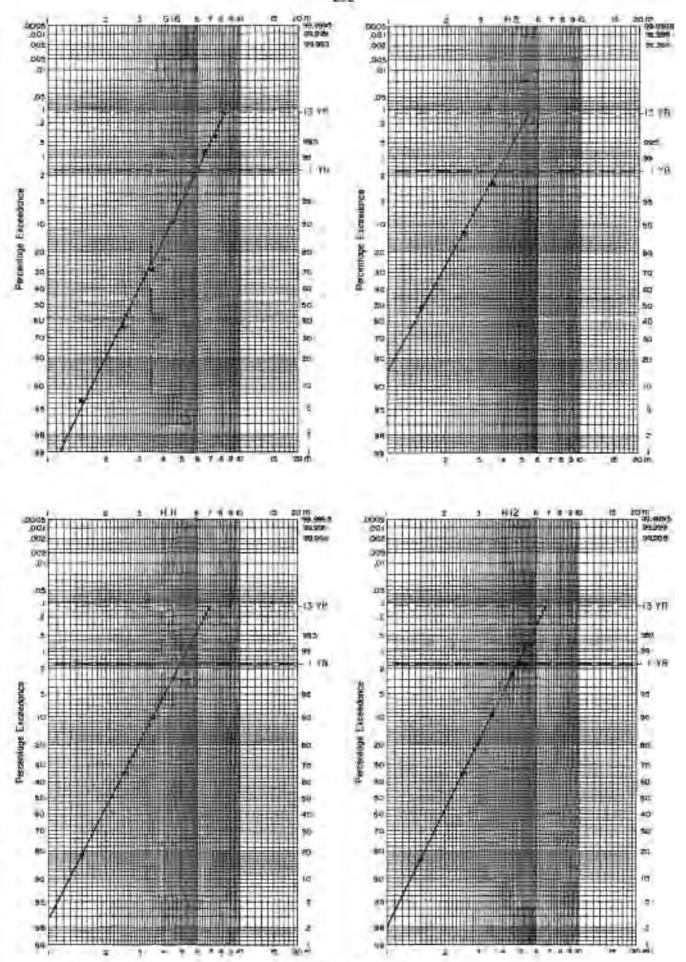


Figure 3u Monthly Wave Height Exceedance Distribution for Saptember

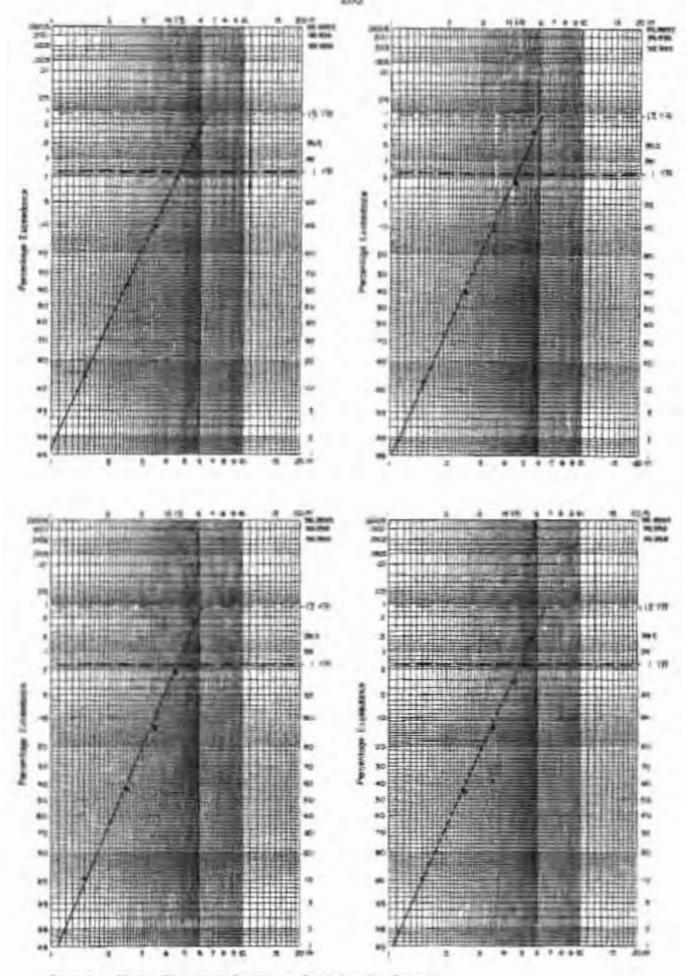


Figure (by Monthly Wave Height Exceedance Distribution for Secrember

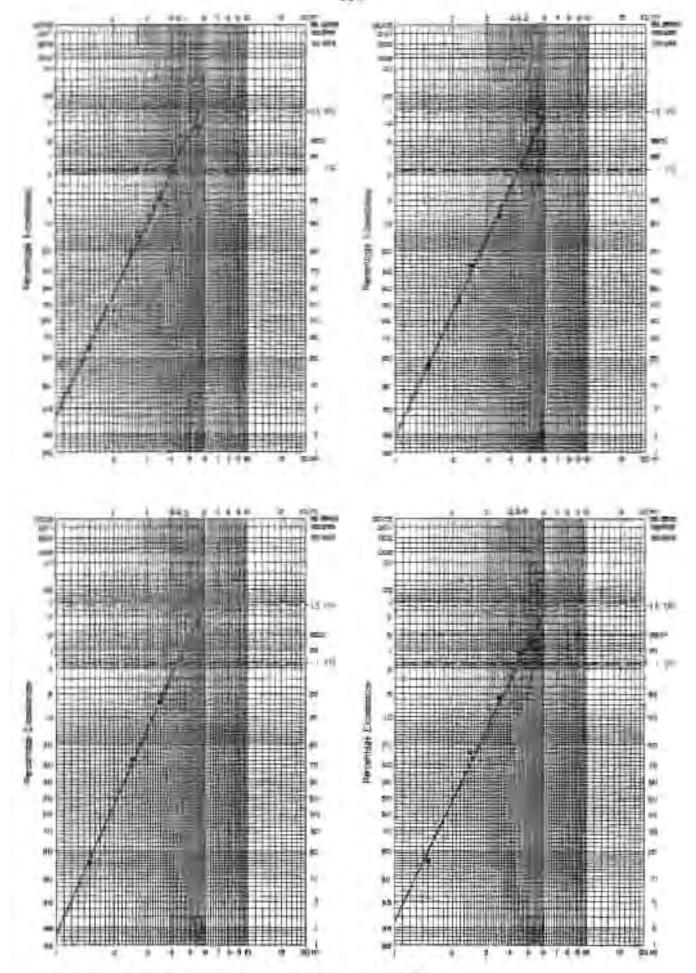
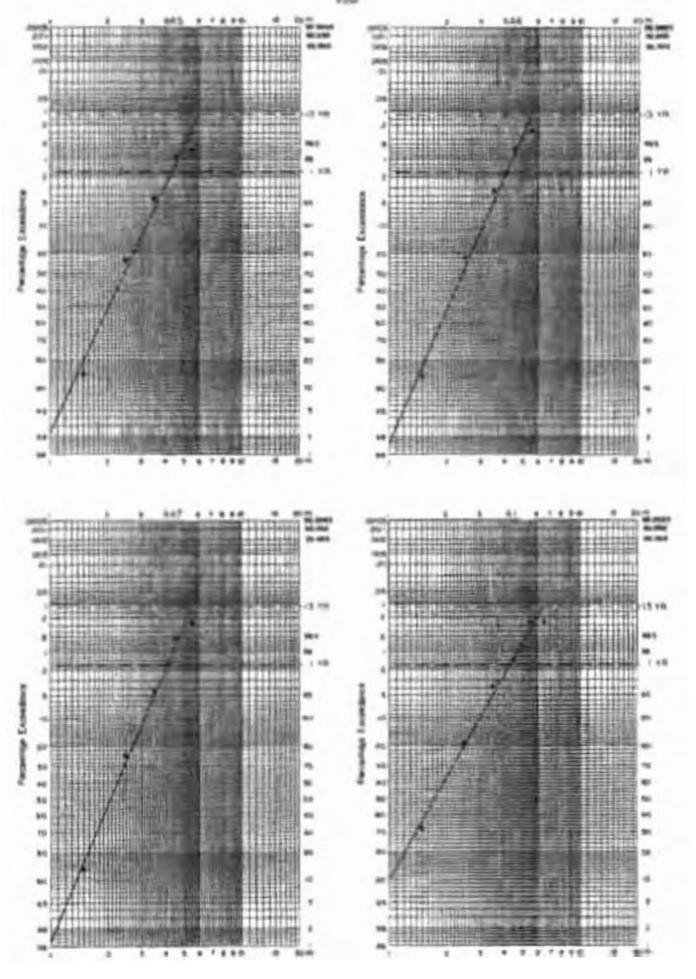


Figure II.it. Monthly Wave Height Exceedance Distribution for October





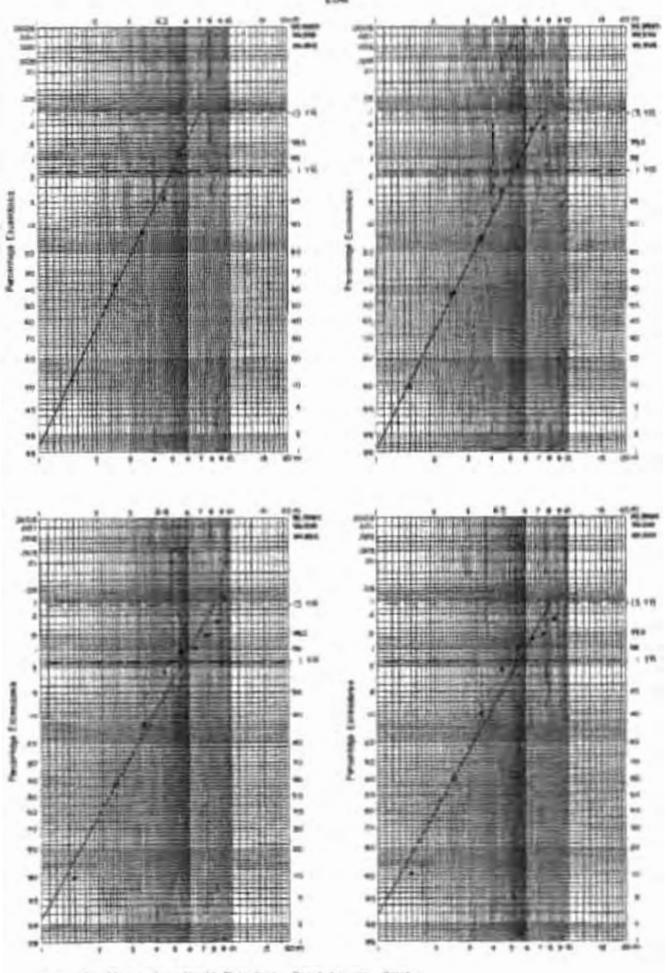
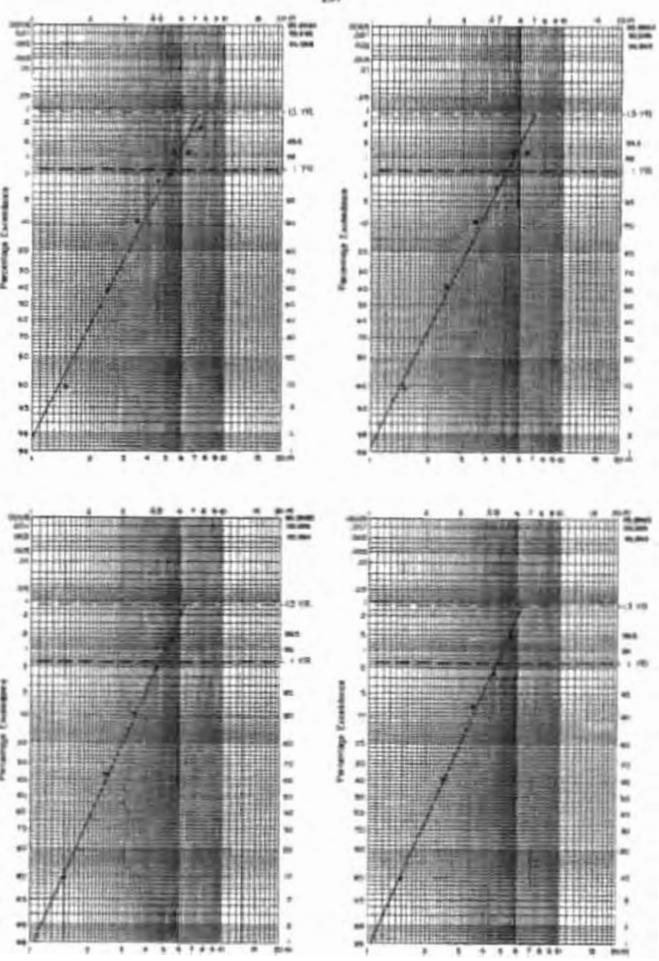


Figure IDc. Mourray Wove Height Excendence Distribution for October



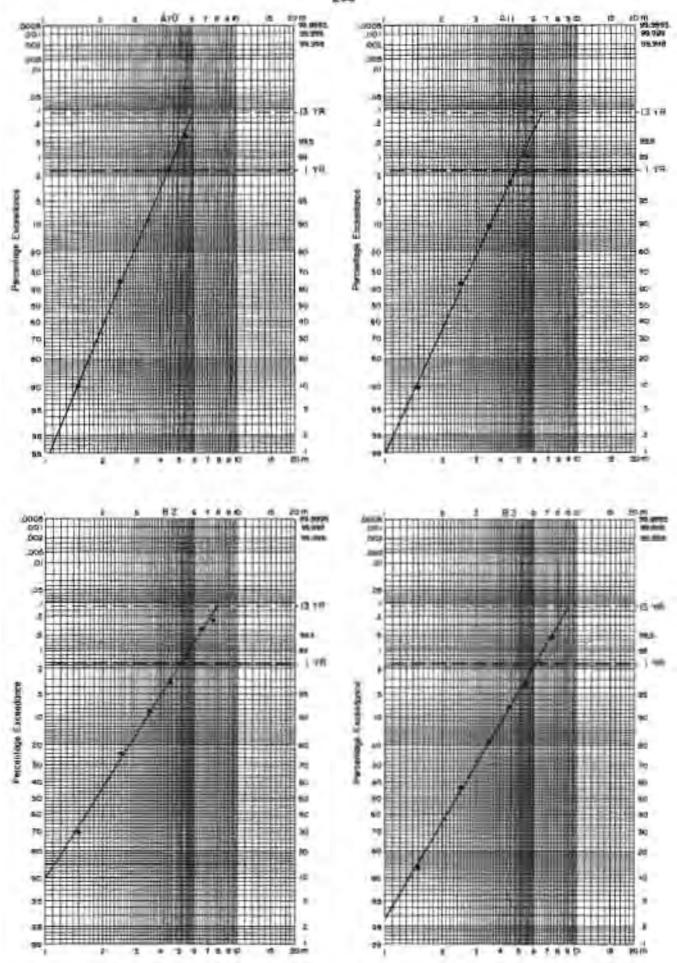
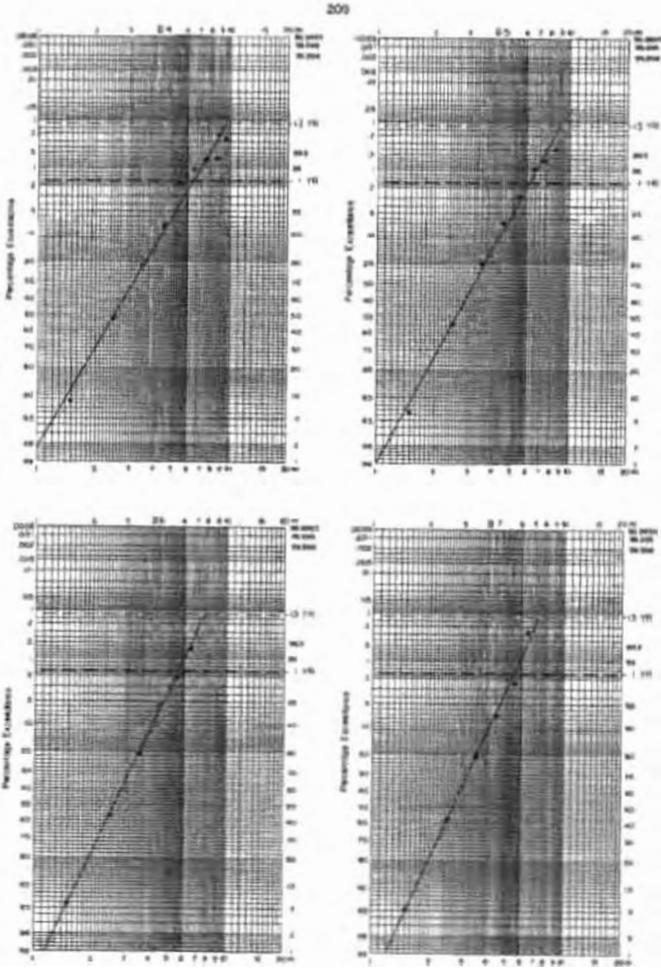


Figure Ce. Monthly Wave Height Exceedance Distribution for October



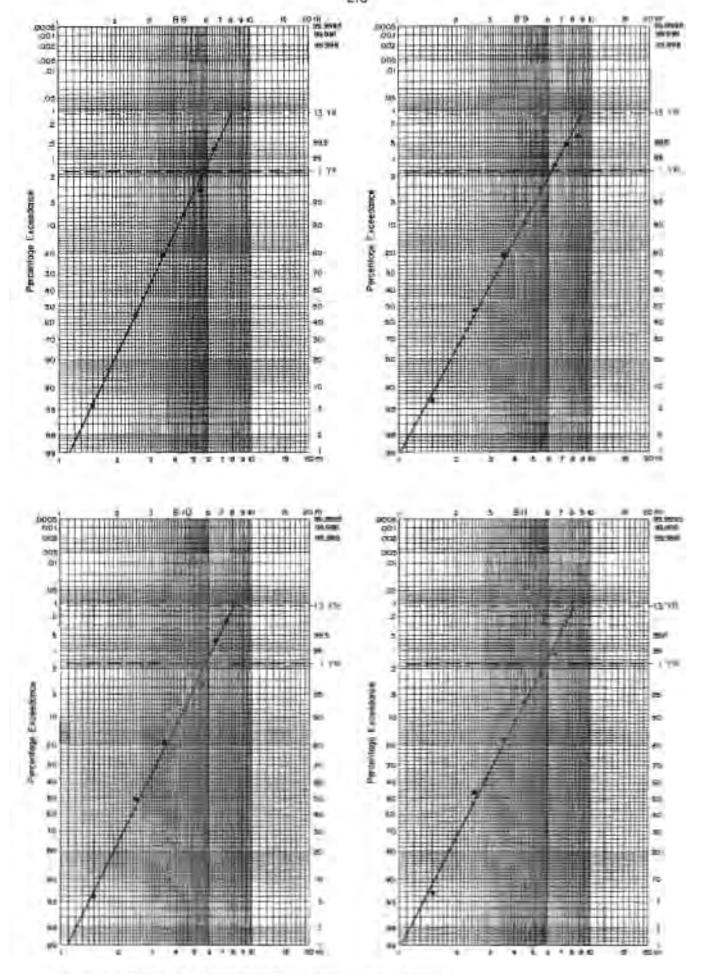
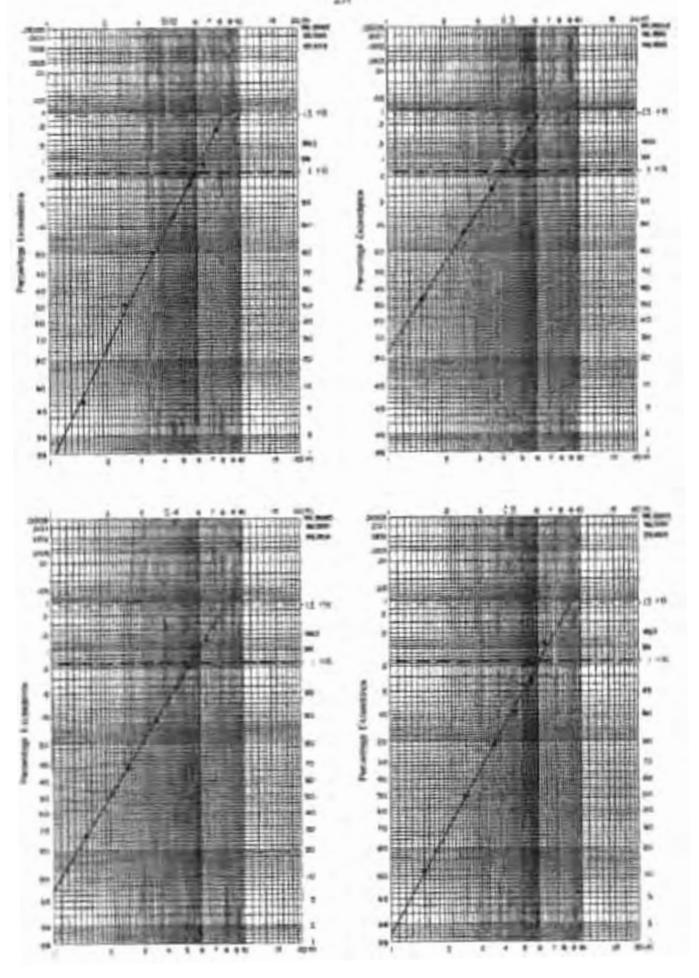


Figure (Dig. Monthly Wave Height Exceedance Castribution for October





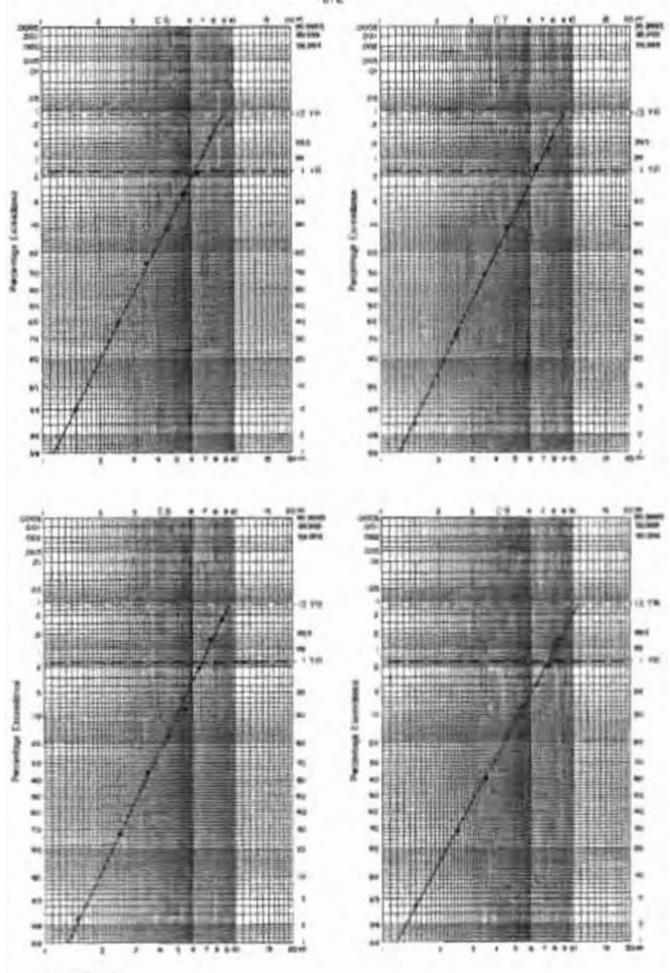


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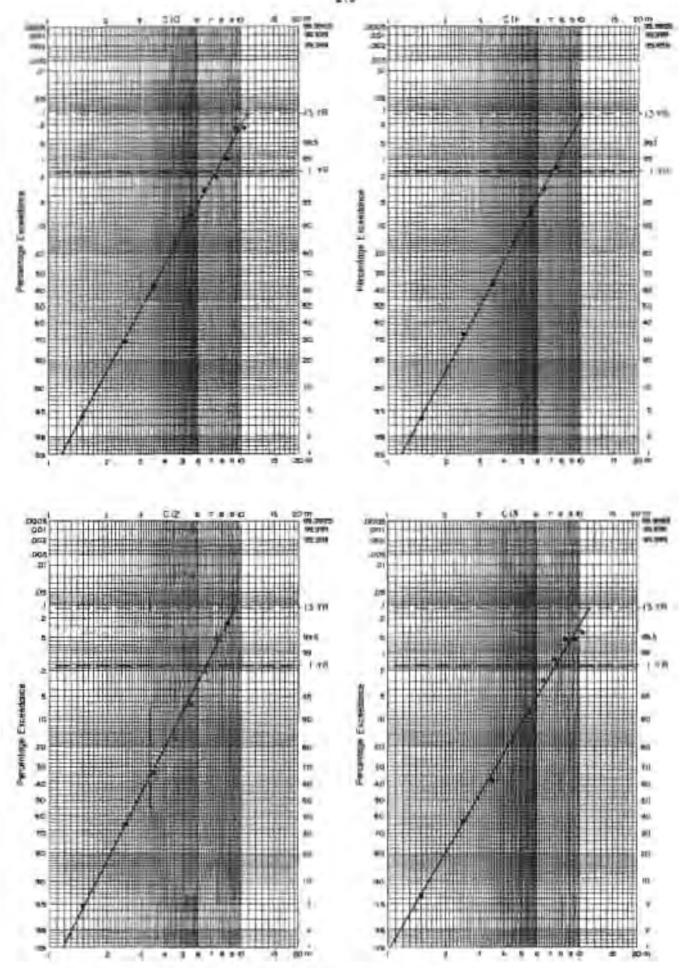
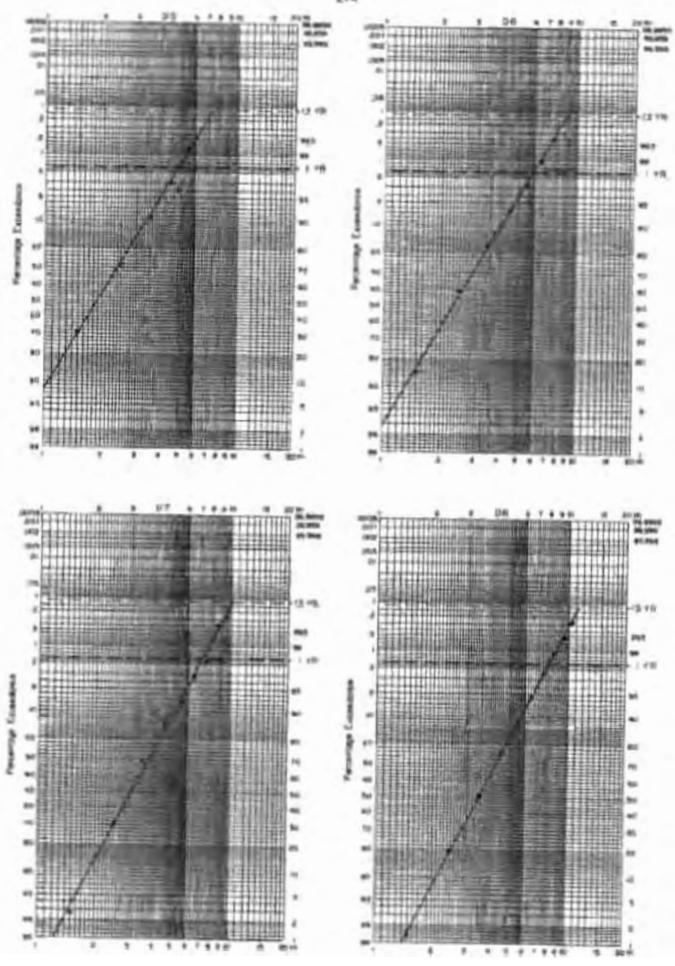


Figure ICi, Monthly Wave height Cacendorica Distribution for October



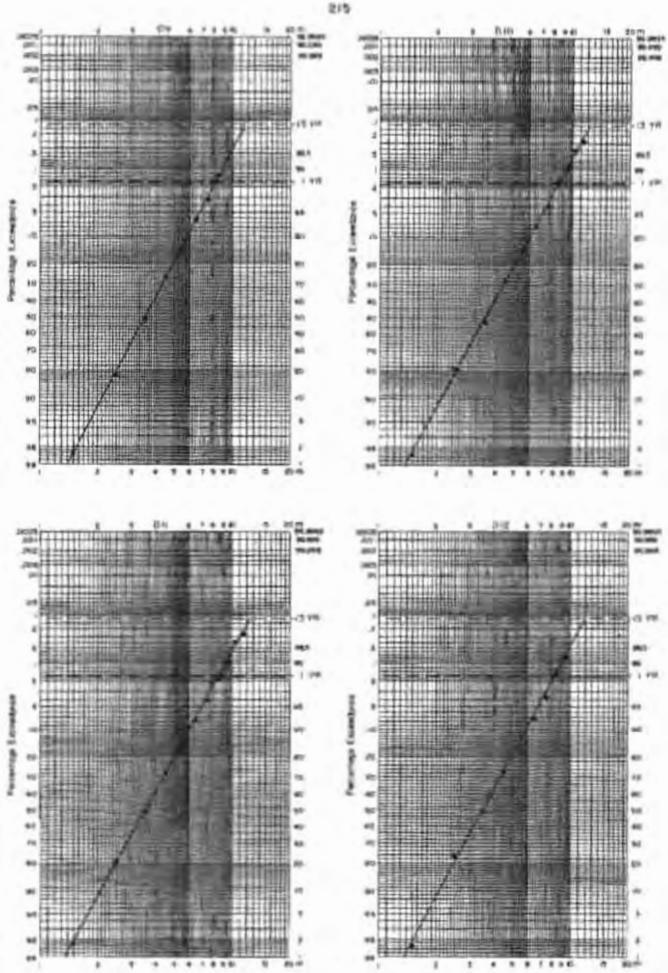


Figure IC: Morthly Move Height Excentures Distribution for October

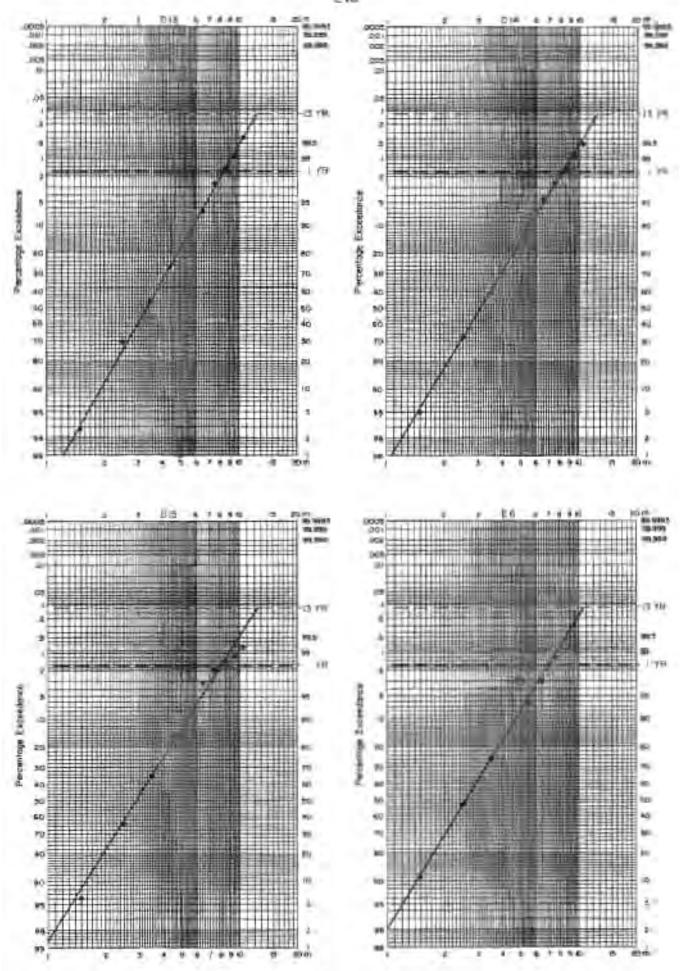


Figure ICIm. Monthly Wove Height Exceedance Distribution for October

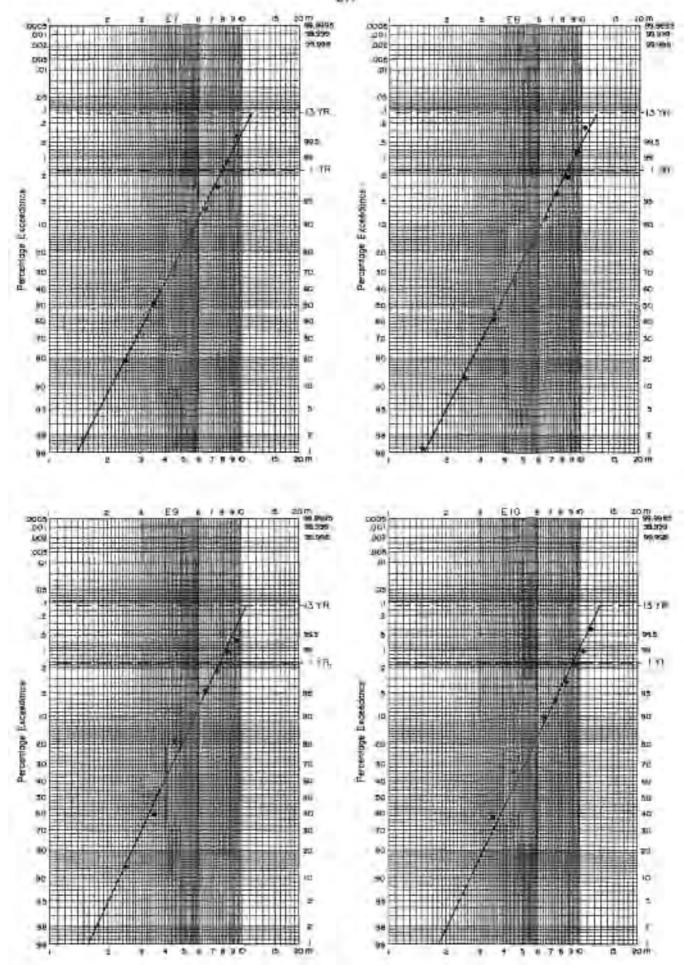


Figure (Tit): Monthly Wave Height Exceedance Distribution for October

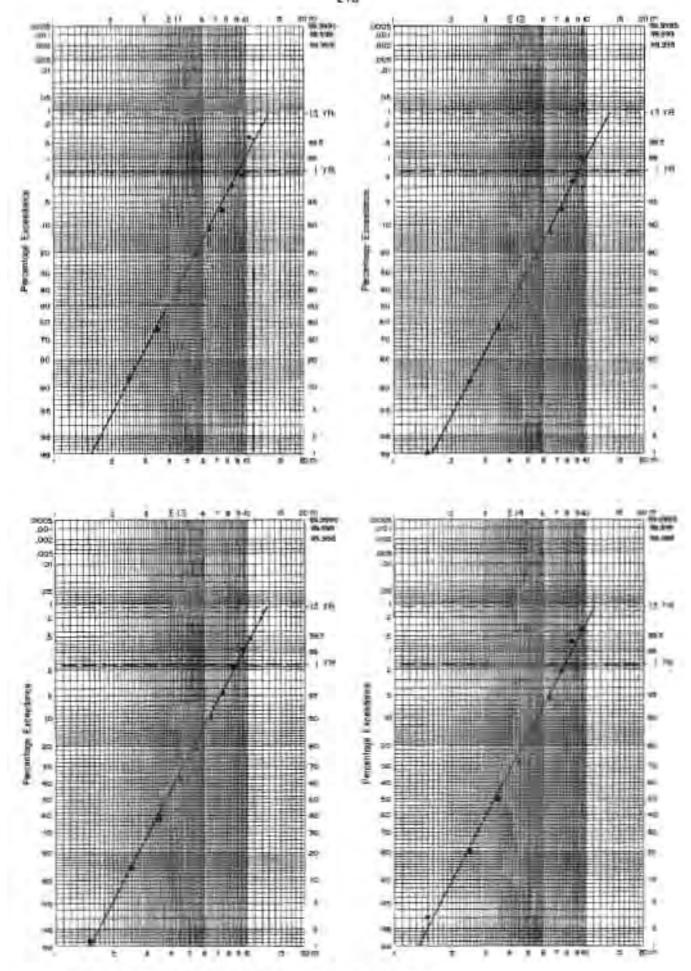
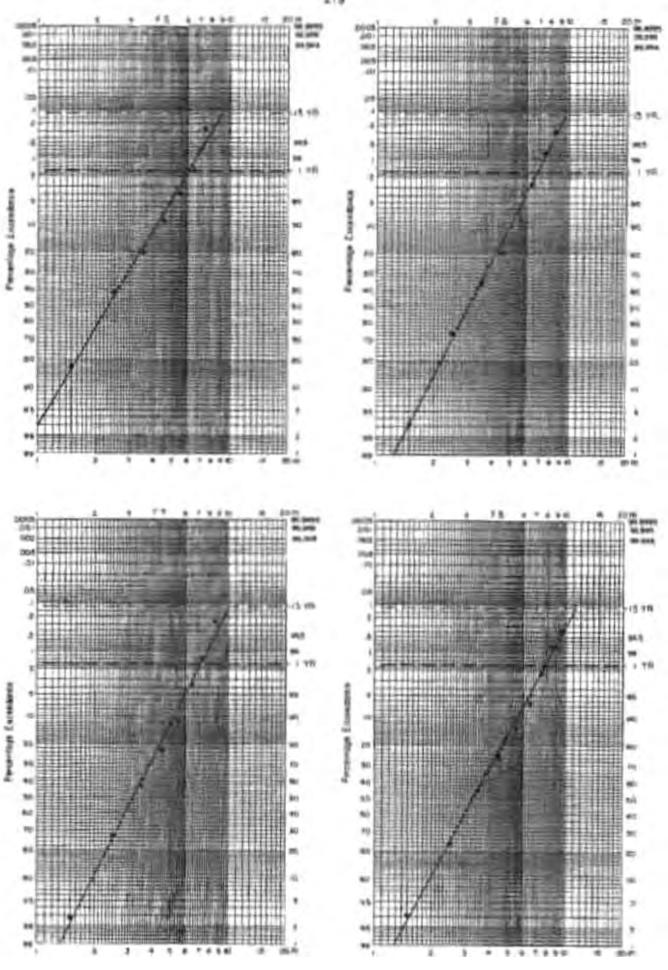


Figure (Cu. Monthly Work Height Excendence Distribution for October



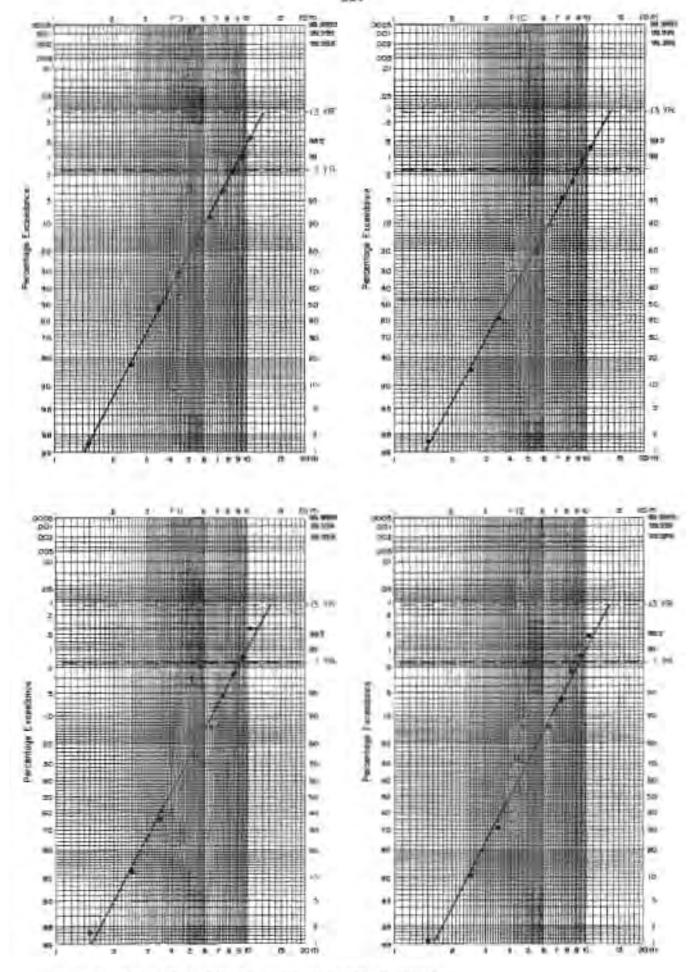


Figure Og. Monthly Wove Height Exceedance Distribution for October

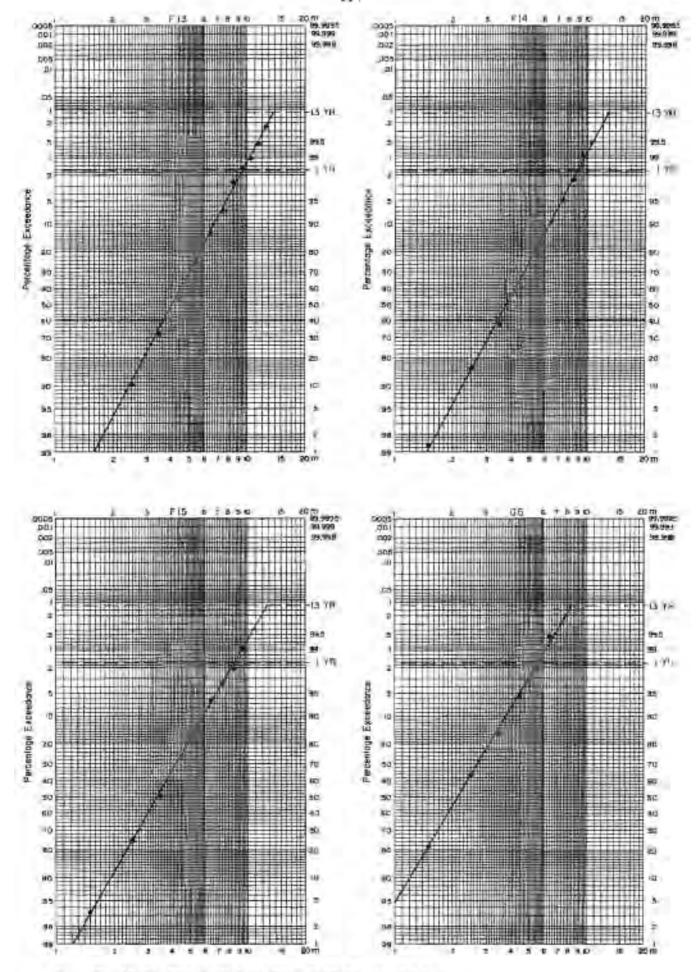


Figure IOr Monthly Wave Height Exceedance Distribution for October

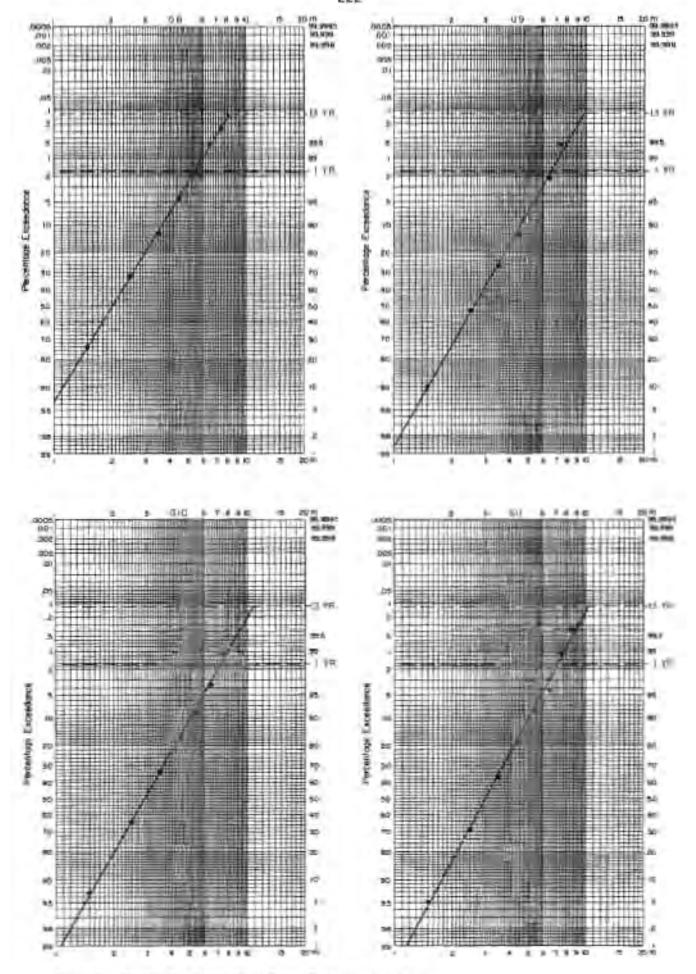


Figure (Dis. Movimily Weste Height Excendings Distriction for Distriction

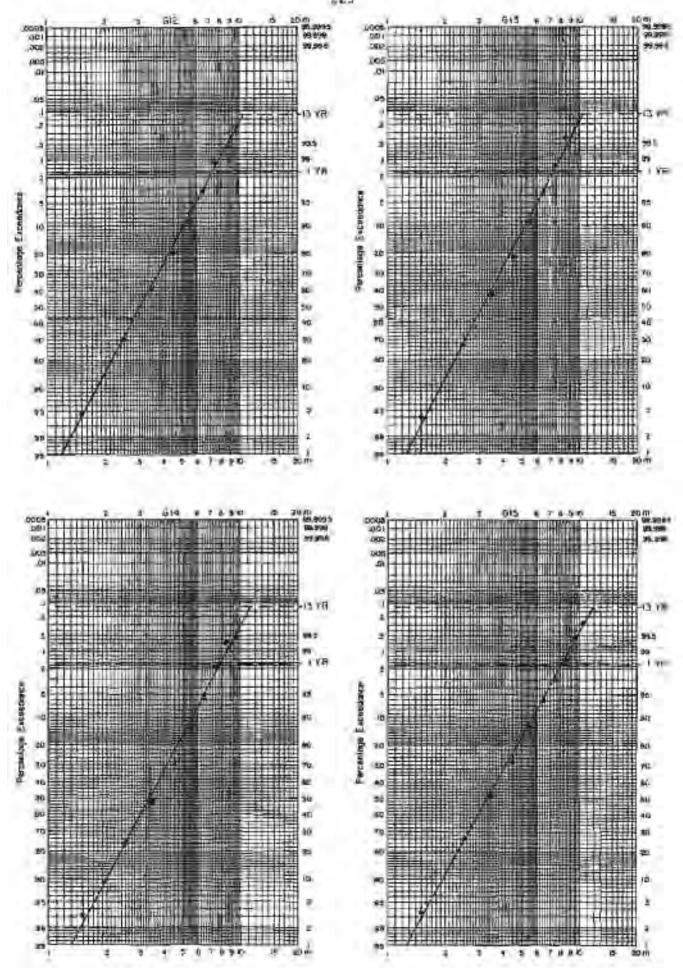


Figure IO1 Monthly Wave Height Escendance Distribution for October

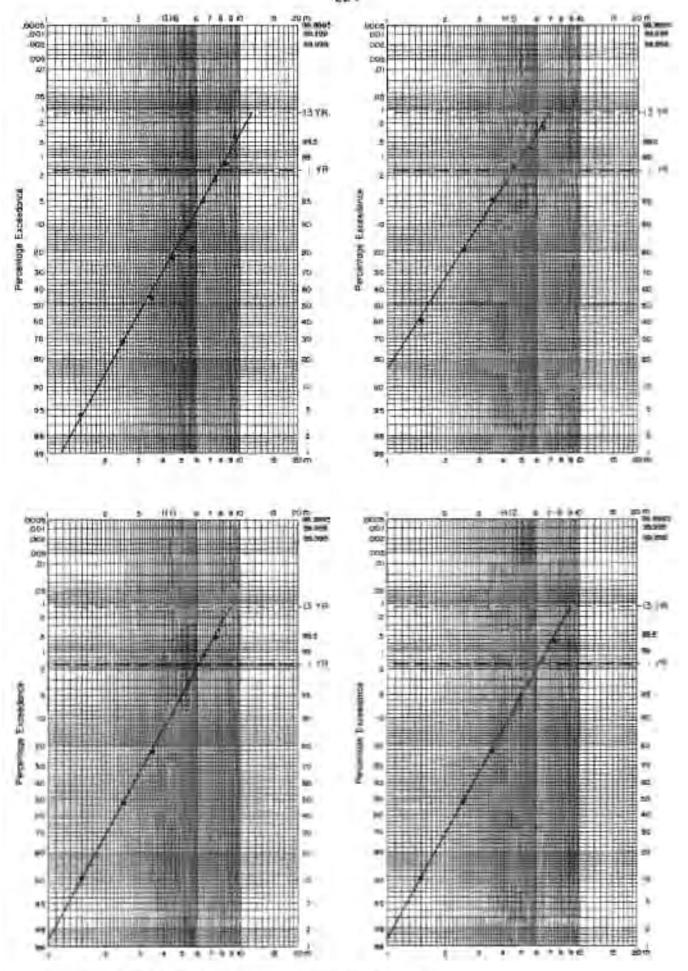


Figure Clu. Monthly Move mergin Escendinics Distribution for October

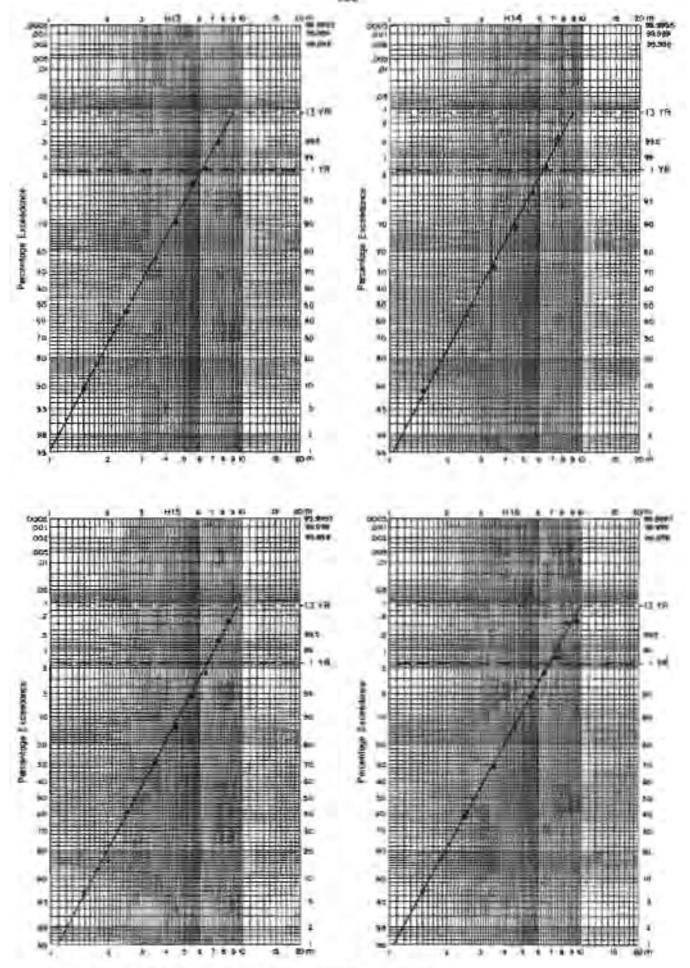


Figure Cir. Monthly wave Hagai Exceedance Distribution for October

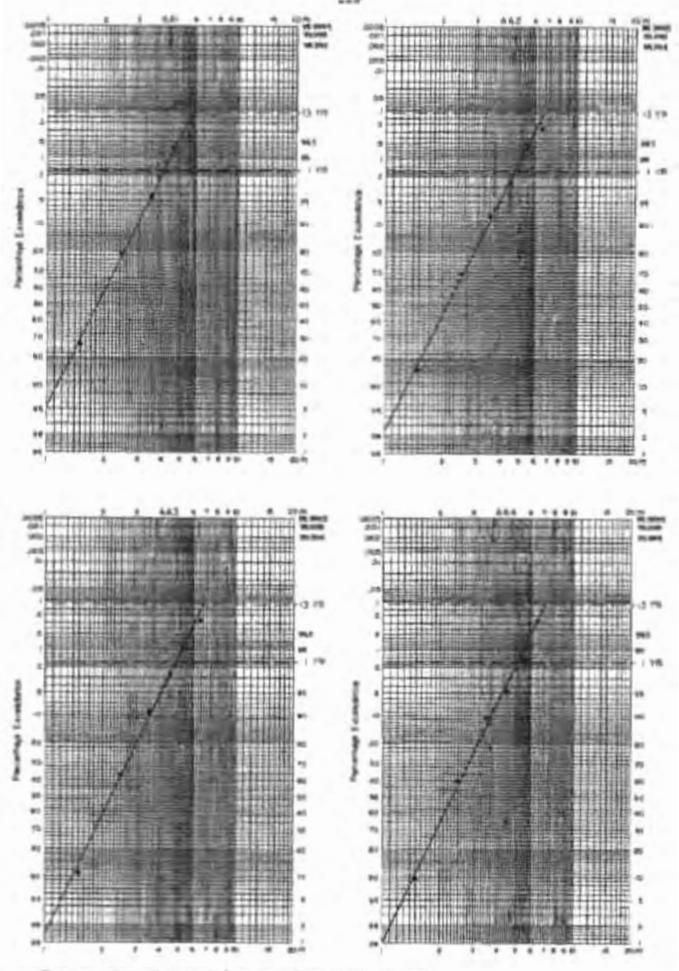


Figure III. Monthly Work Height Exceptorice Distribution for November

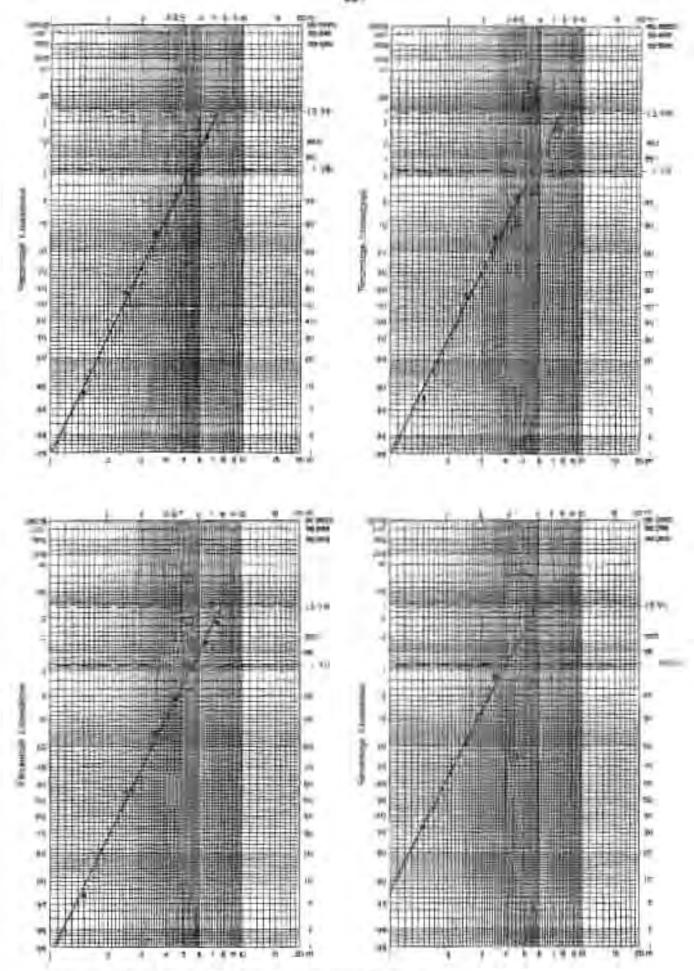
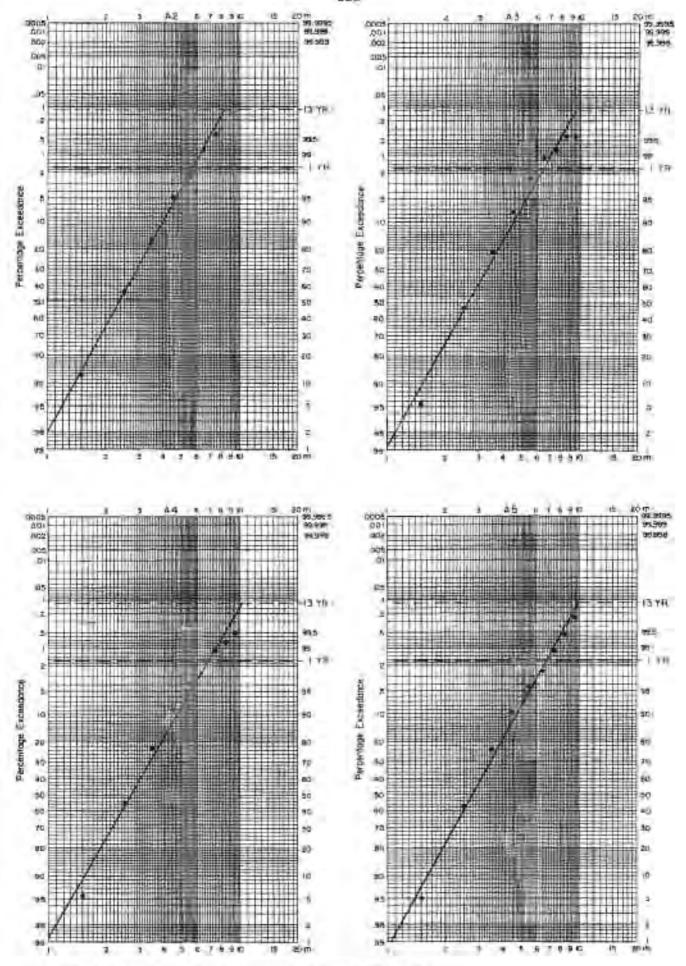
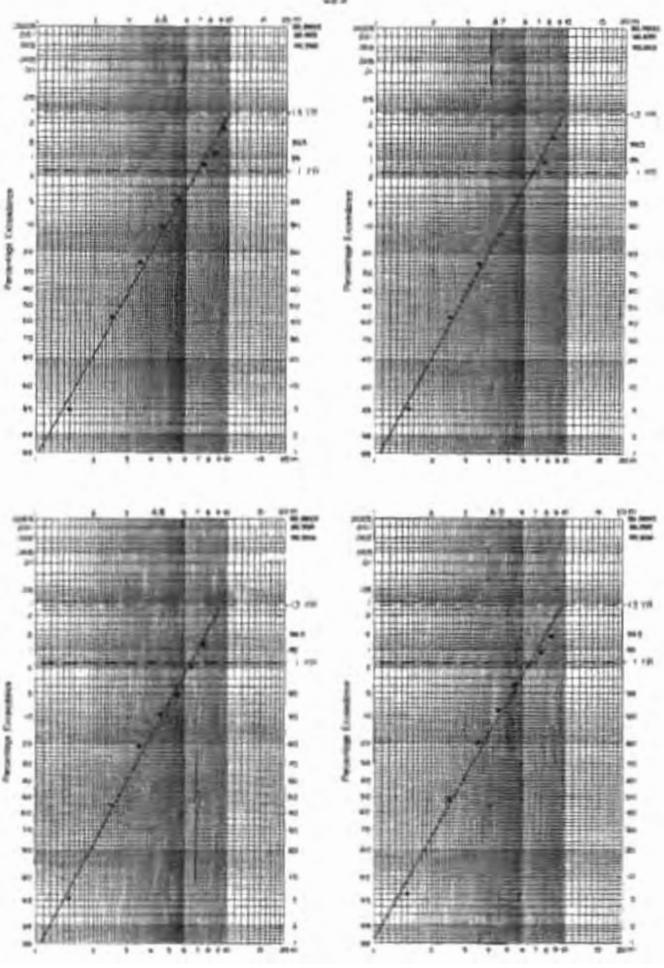


Figure (fit. Monthly Wave Height Exceptions) Distribution for November



Elgarette Manthly Wave Height Exceptionica Distribution for Nevember



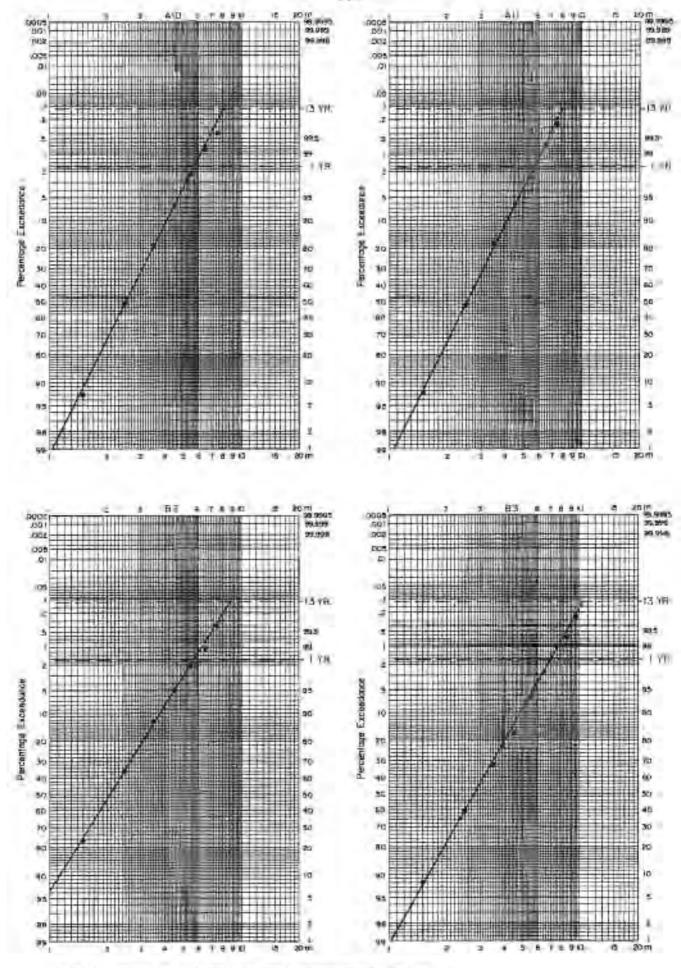


Figure He Monthly Wave Height Exceedance Listriculian for November

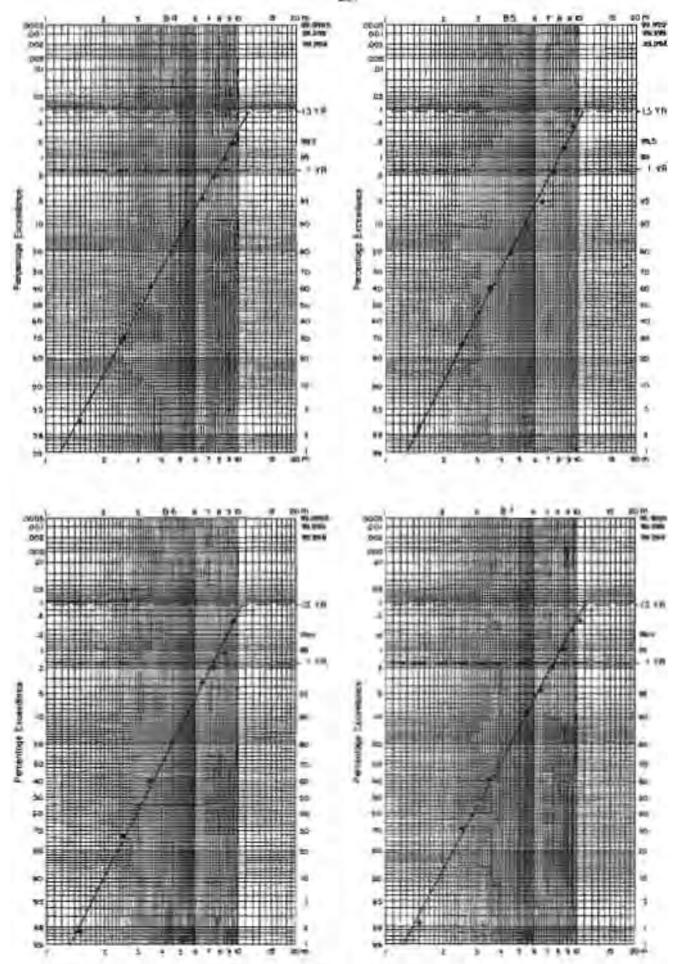
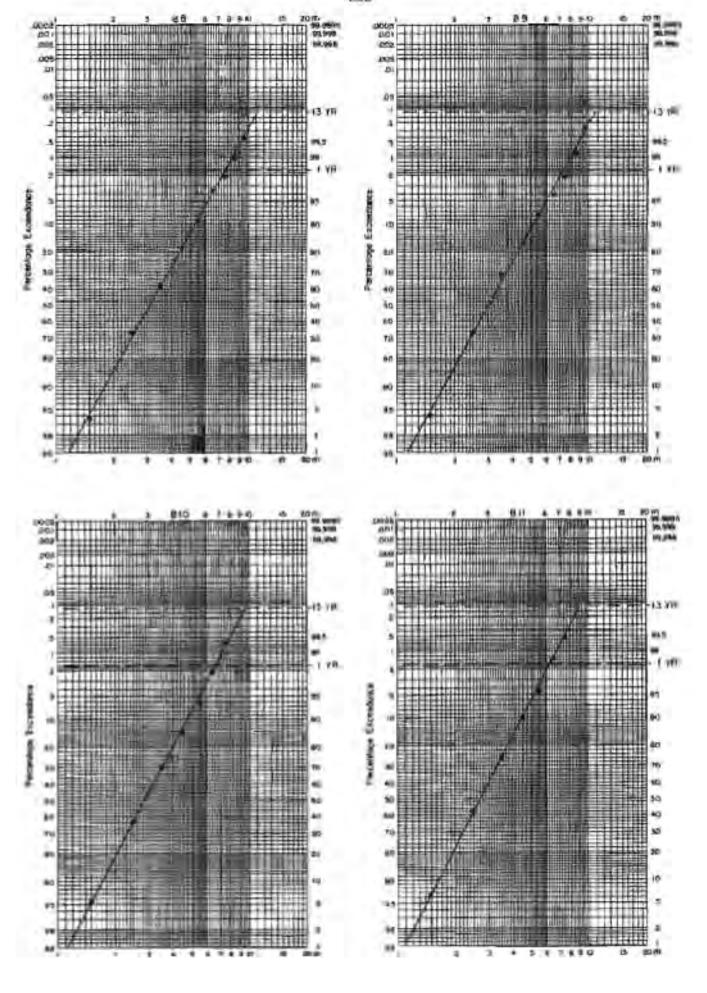


Figure III Monthly Wow I Height Excandance Distribution for November



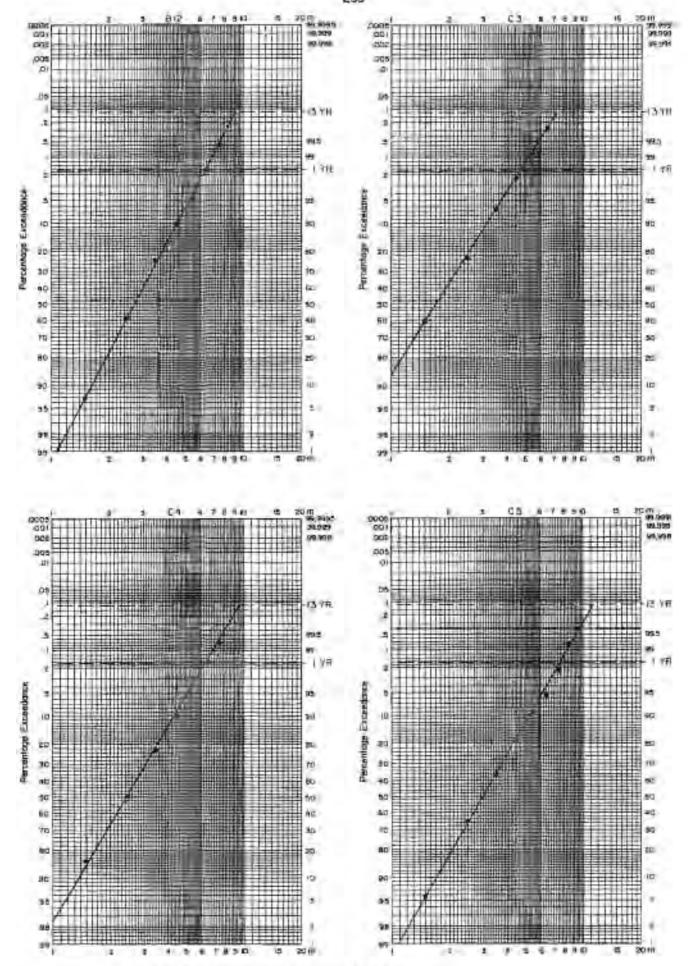


Figure I'm. Monthly Wave might Exceedance Distribution for November

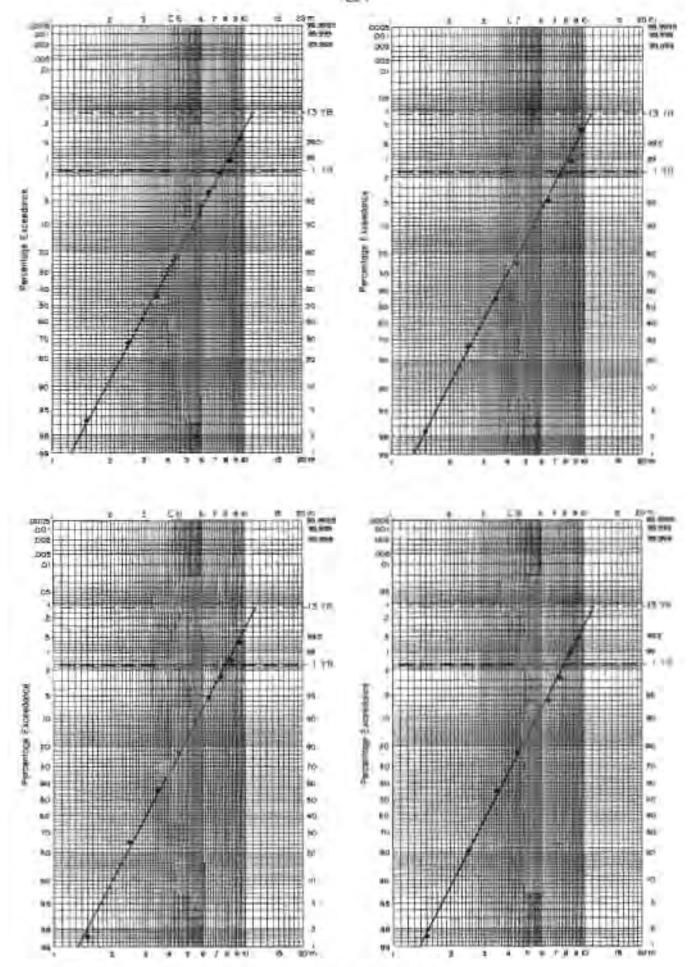


Figure III Monthly Wave Height Exceedance Distribution for November

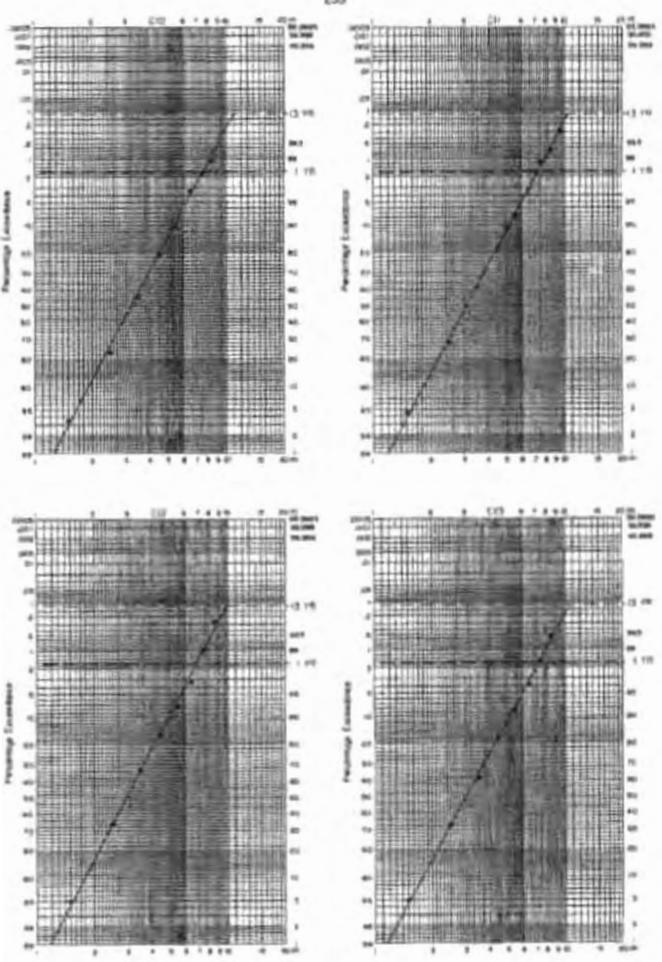


Figure (1) - Monthly Moor Height Exceedings Distribution for November



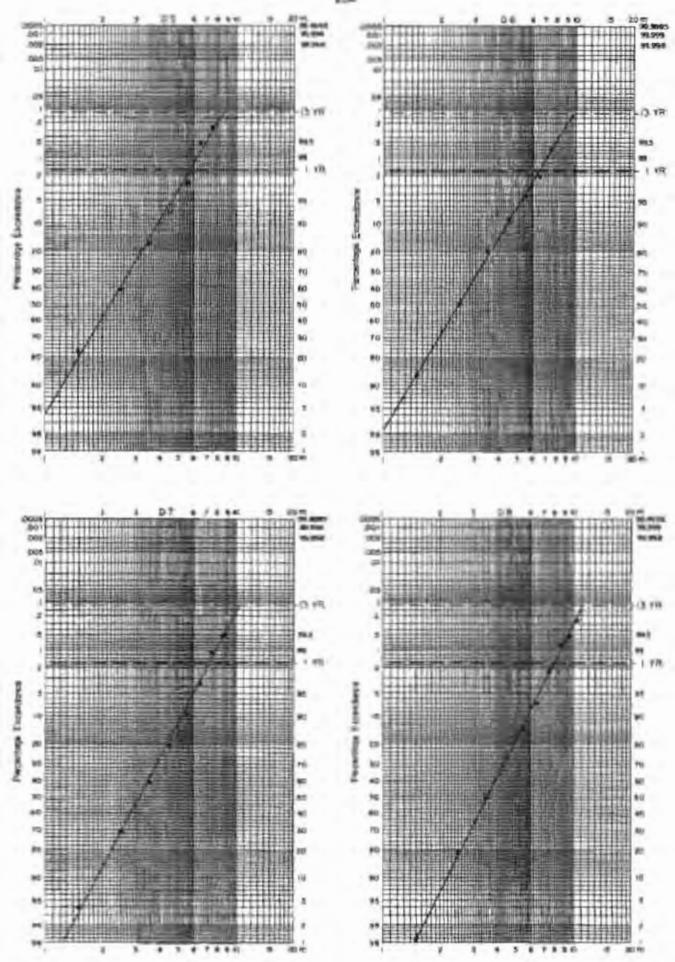


Figure Lie Monthly Wave Height Exceedance Distribution for November

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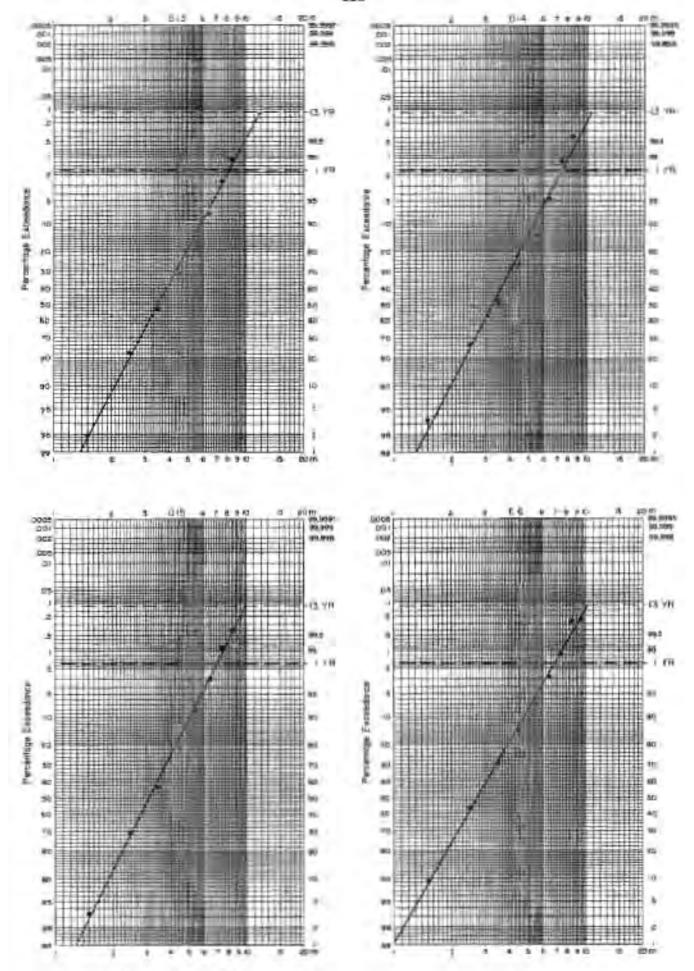
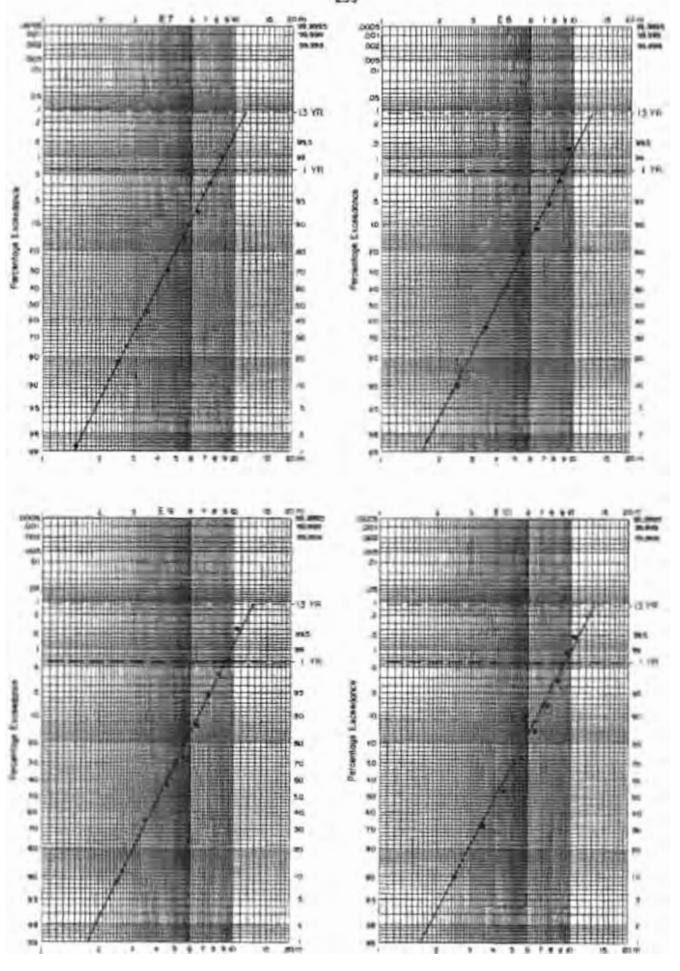


Figure Iron Monthly Wave Height Excendence Distribution for November



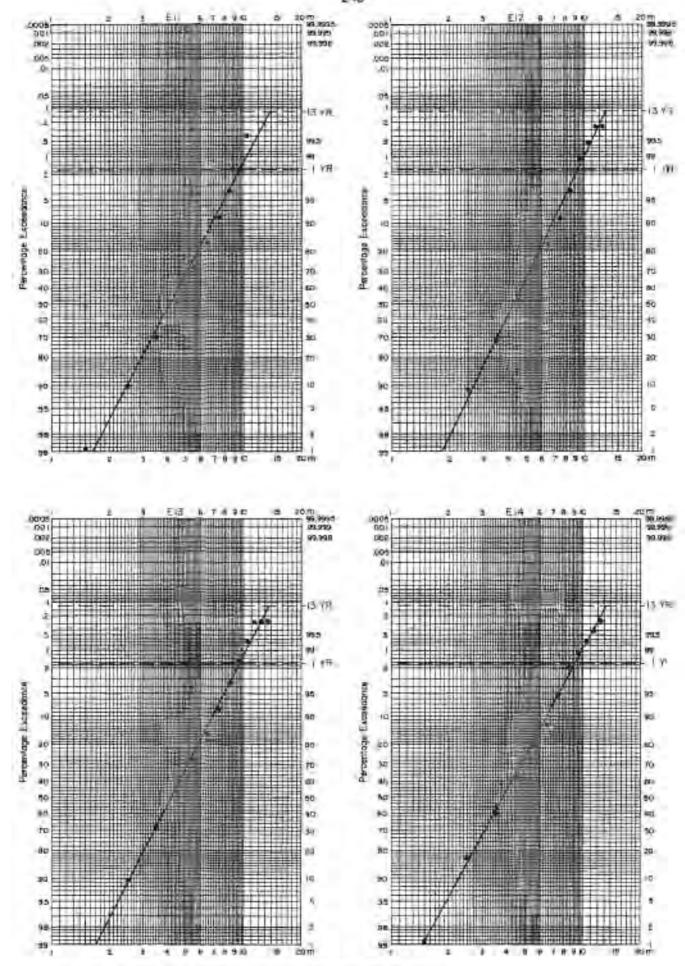


Figure 11a Monthly Wave resign Exceedance Distribution for November

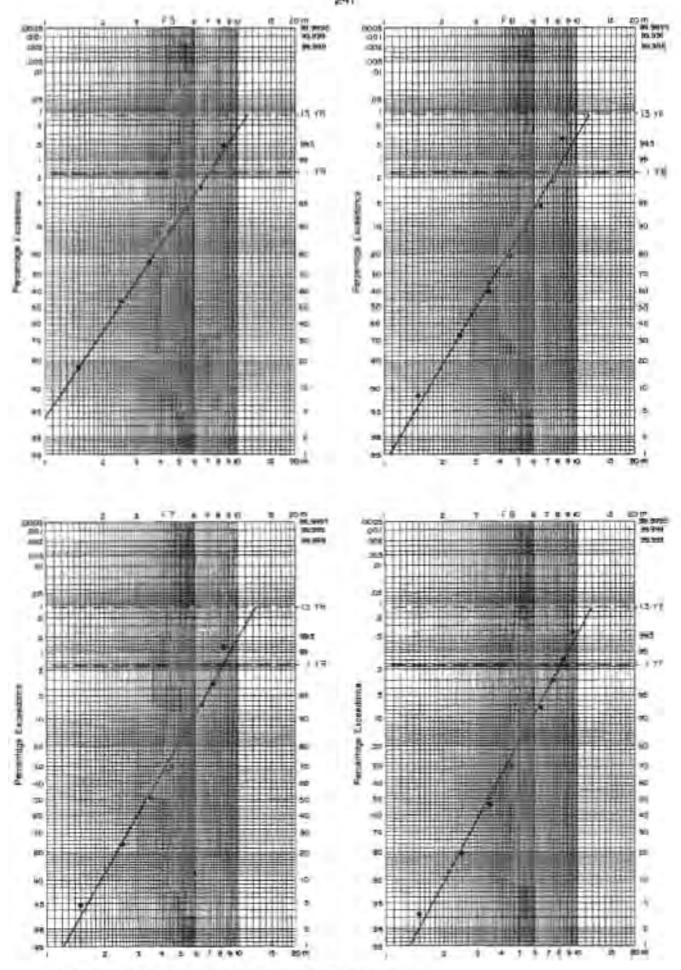


Figure 11b. Monthly Work Height Exceedance Distribution for Neverthe

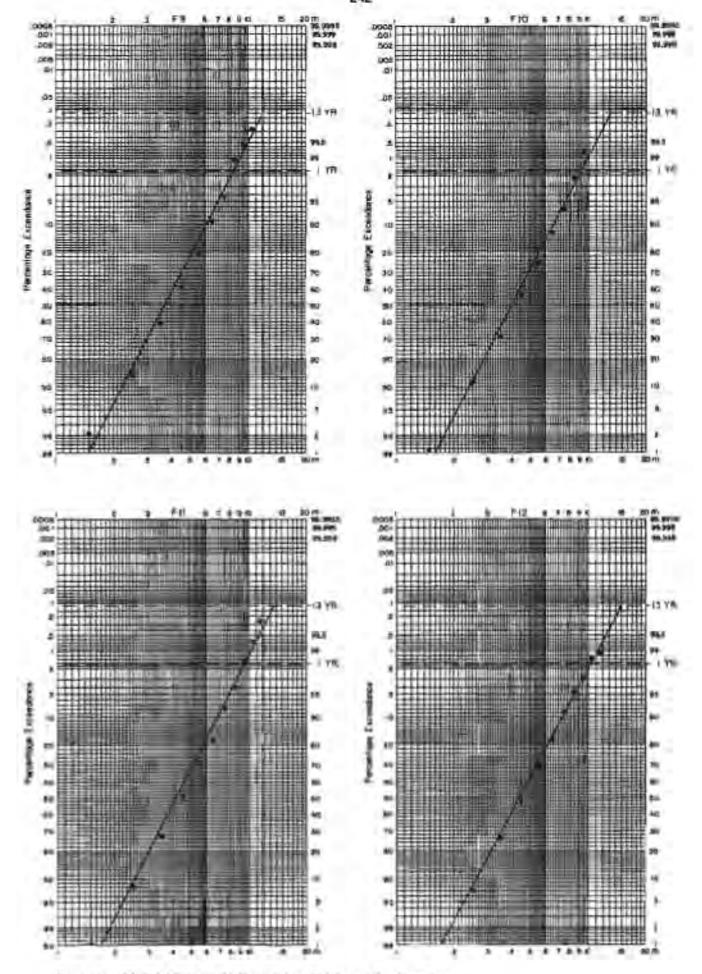
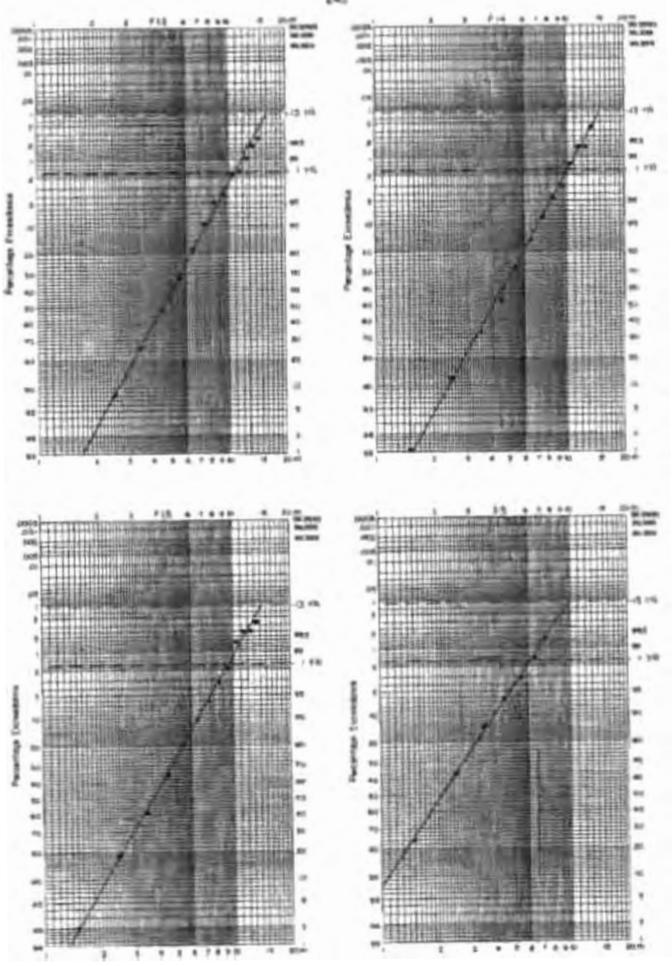


Figure 114 Monthly Wave People Excendence Distribution for November





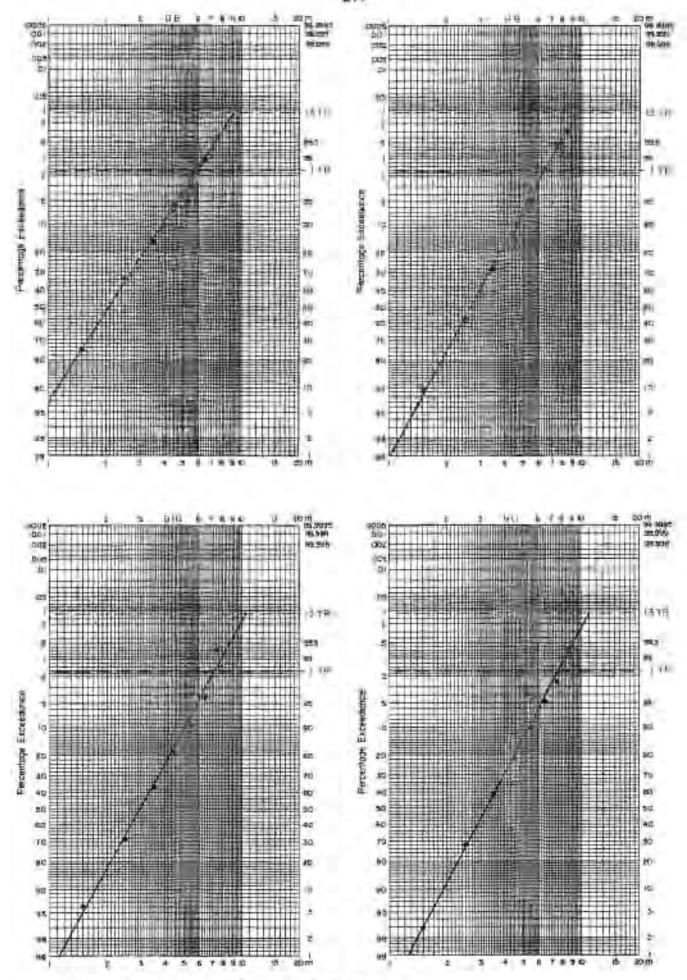
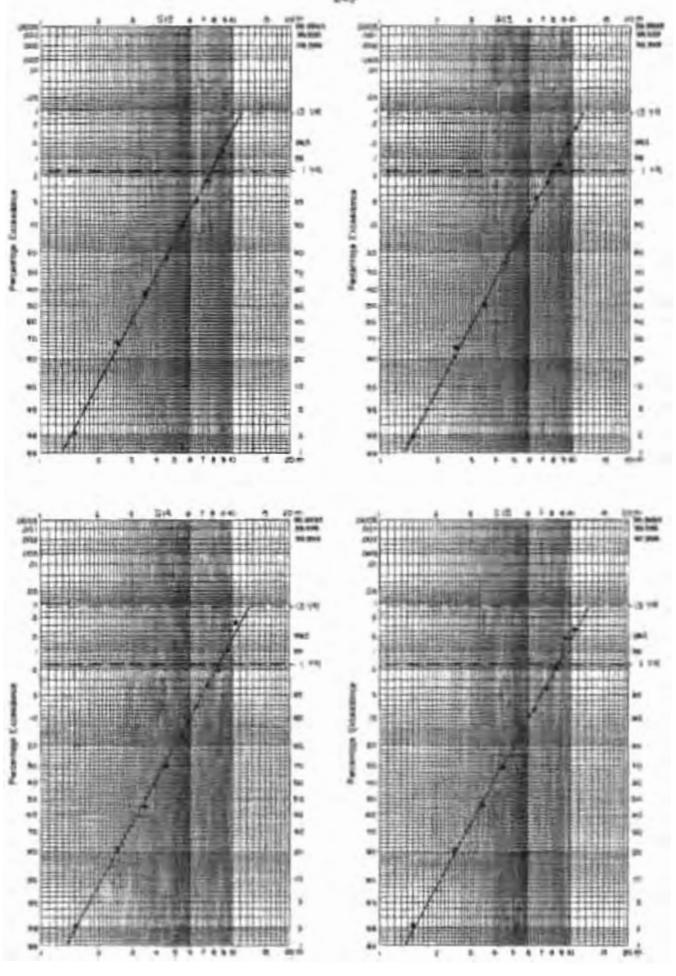


Figure IIIs Monthly Wave Height Exceptionice Distribution for November





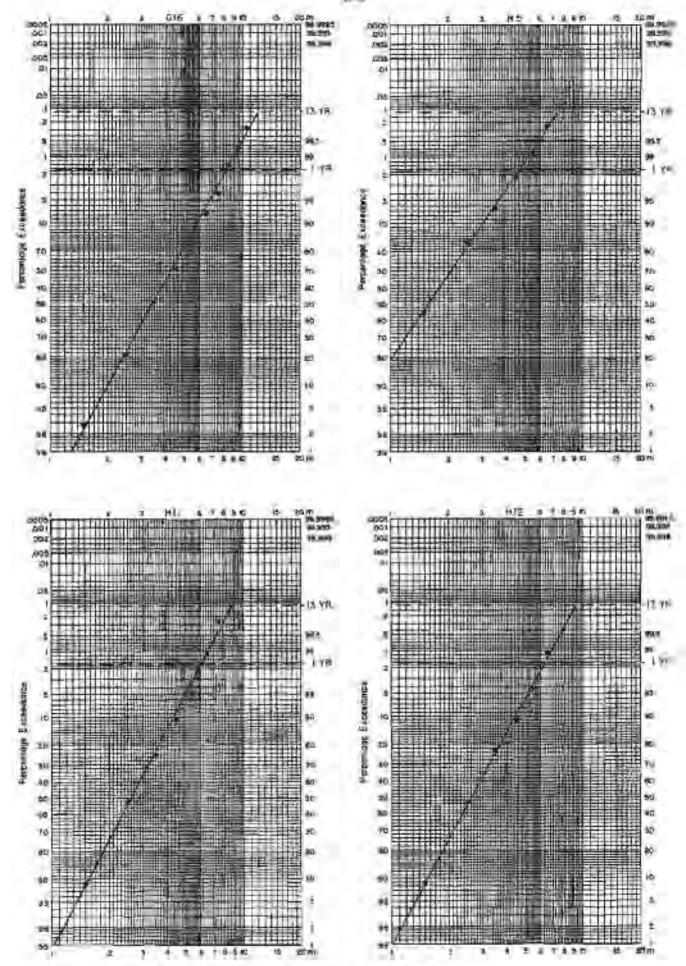


Figure 114. Monthly Wave Height Exceedance Distribution for November

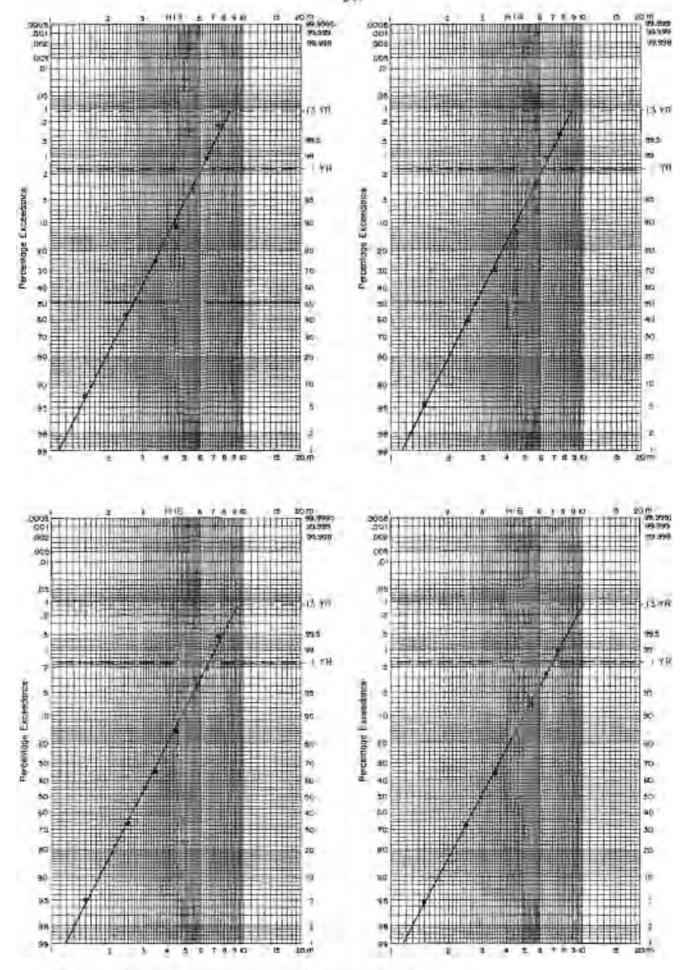
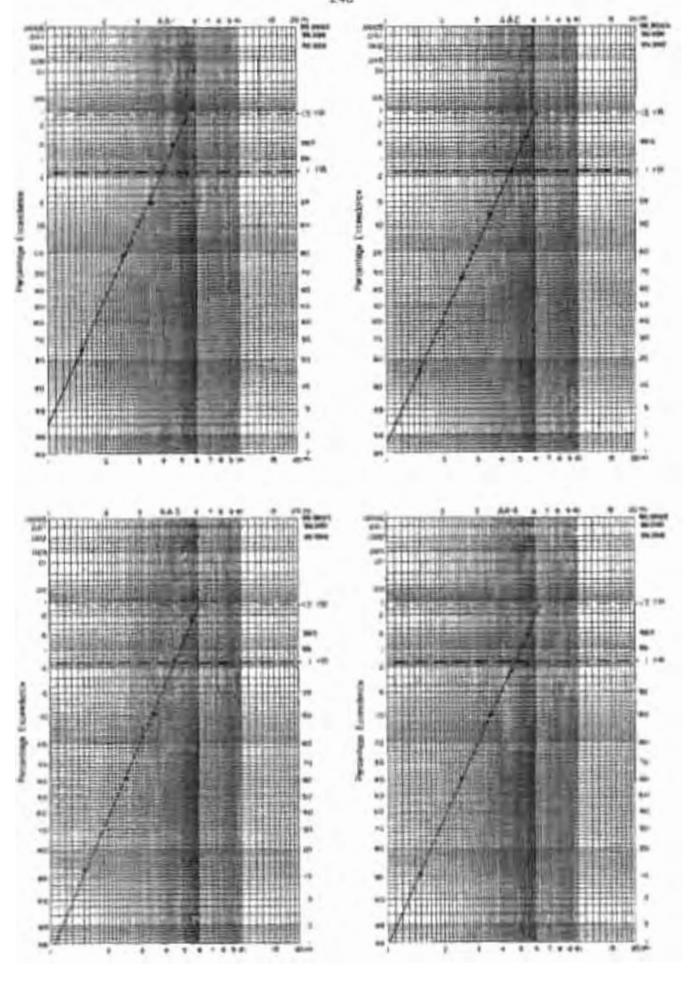


Figure IIV. Monthly Wave Height Exceedance Distribution for Assembler



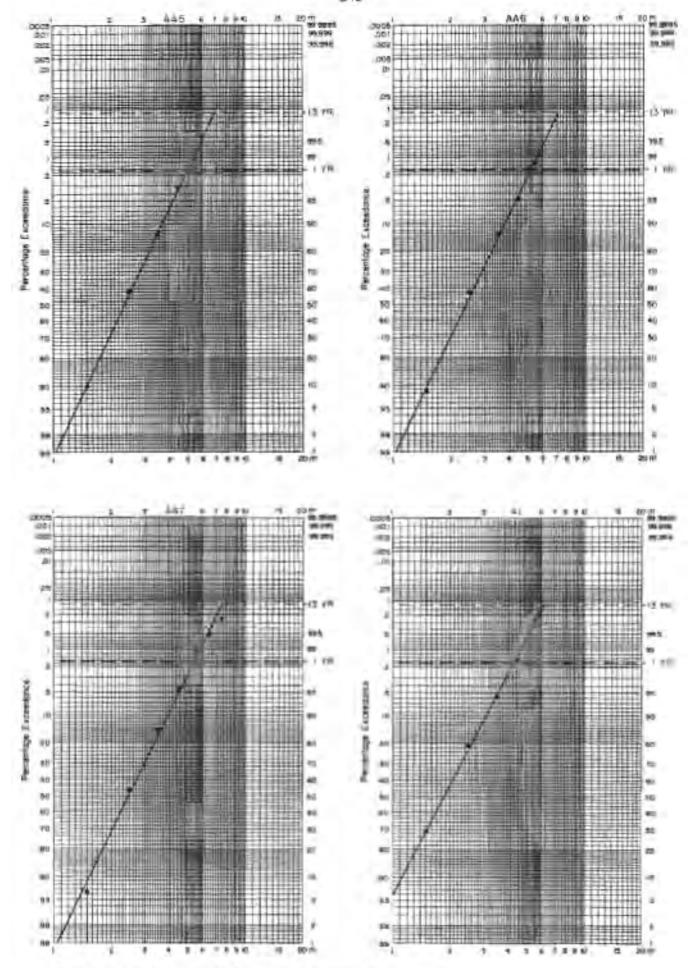


Figure (J.b. Monthly Wave meight Exceediance Distribution for December

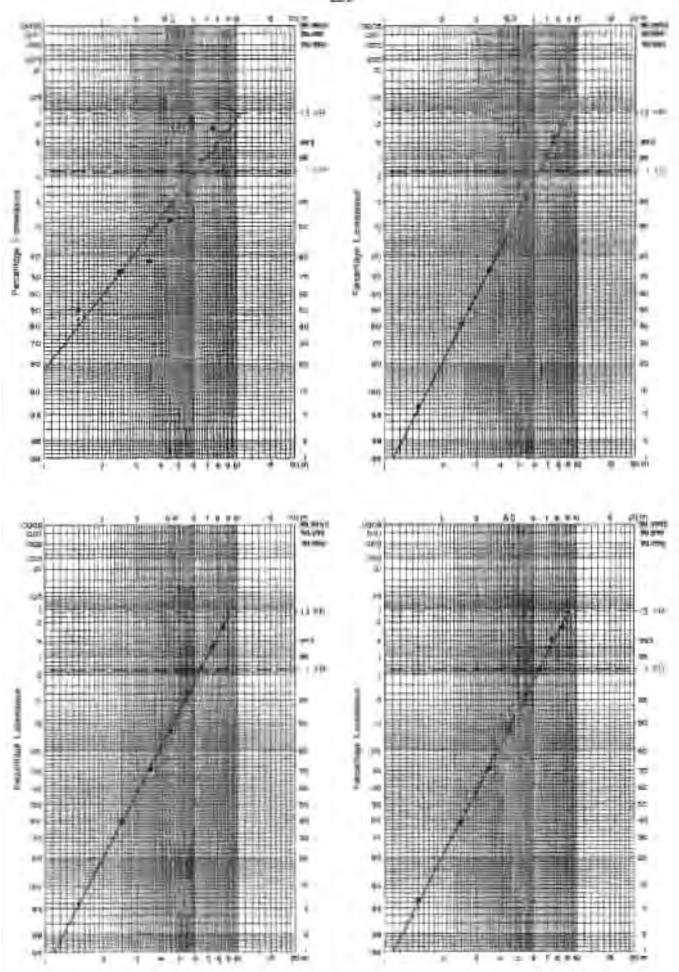


Figure (Eq. Microsy Wave Height Excessioners Thatribulion for December



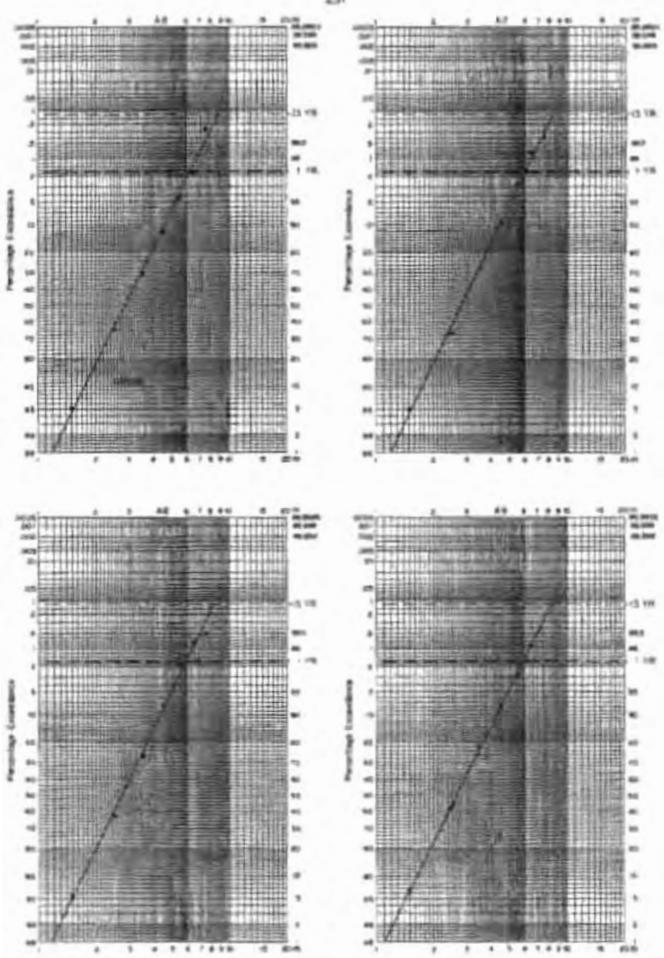


Figure ICo. Monthly Wave Hargin Cooperation Celebration for December



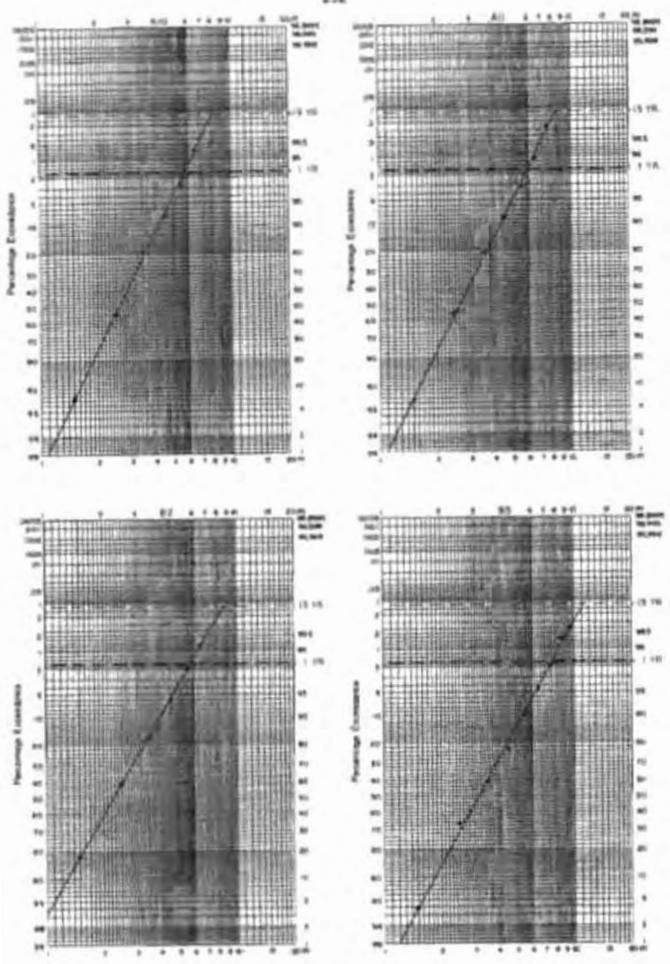


Figure Die Monthly Wave Freight Exceedings Dichitation for December

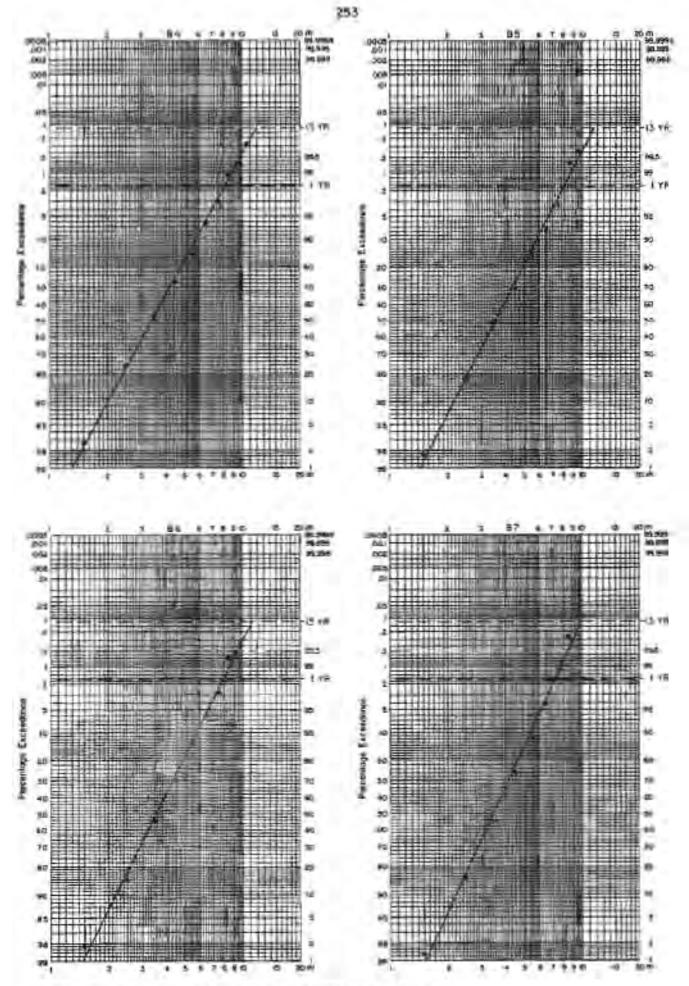


Figure (2) Monthly Wave Height Exceptionce Distribution for December



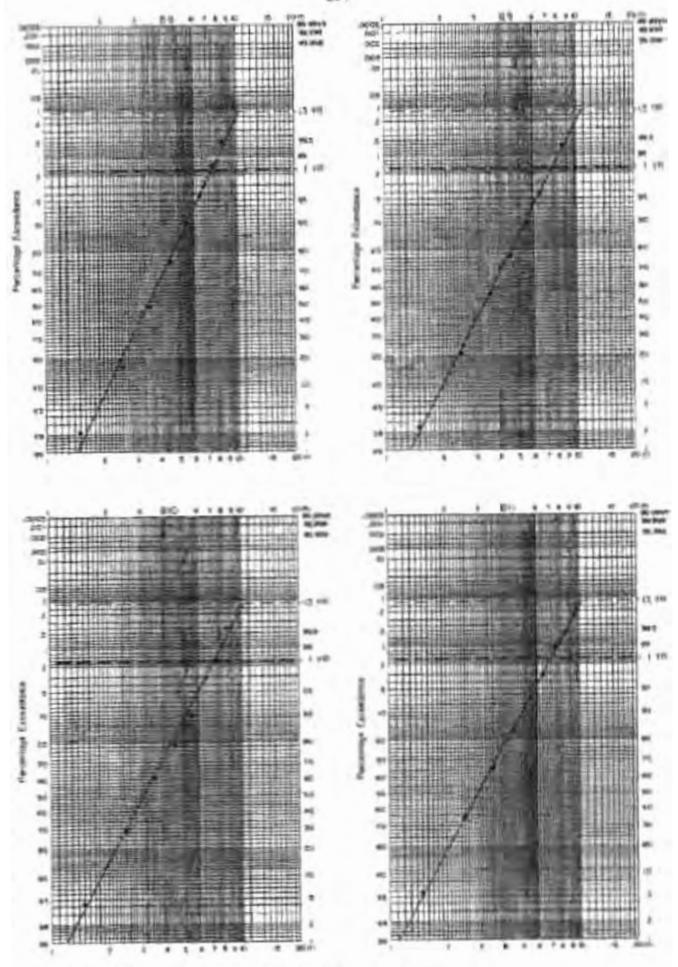


Figure 1/9 Monthly Works Height Exceptionics Tristribution for December

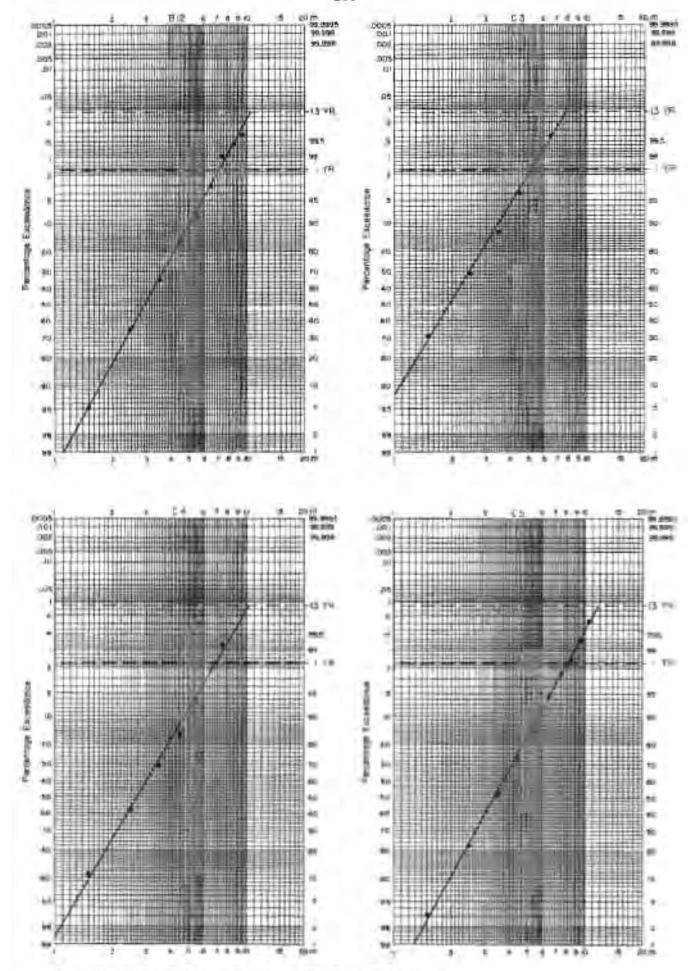


Figure I21. Monthly Wave Height Excentionical Distribution for December

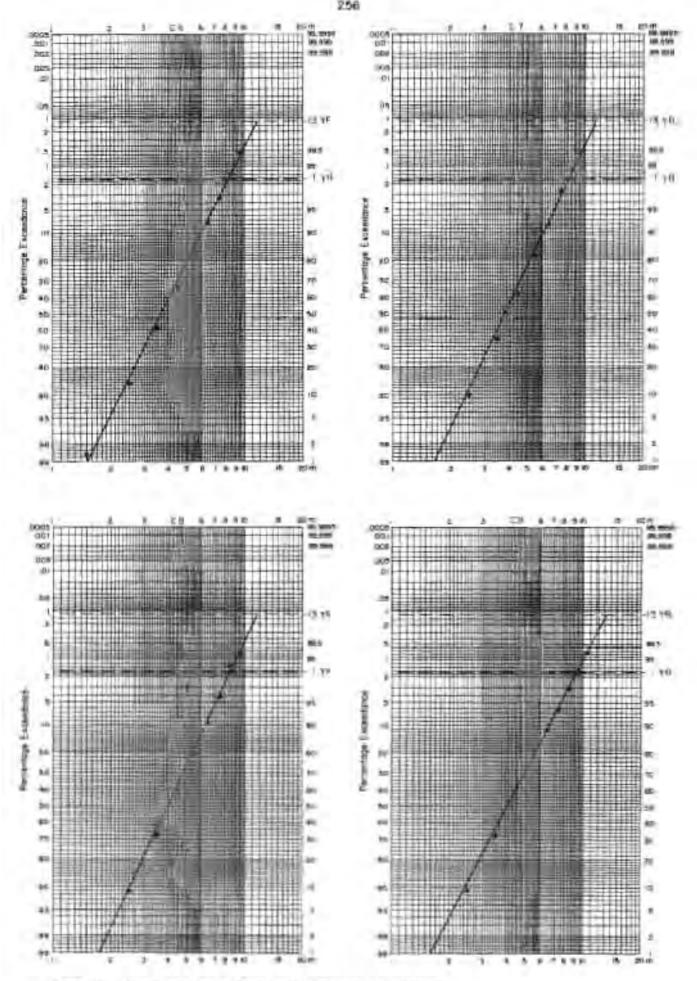


Figure Q. Morring Wave Height Exceedance Distribution for December

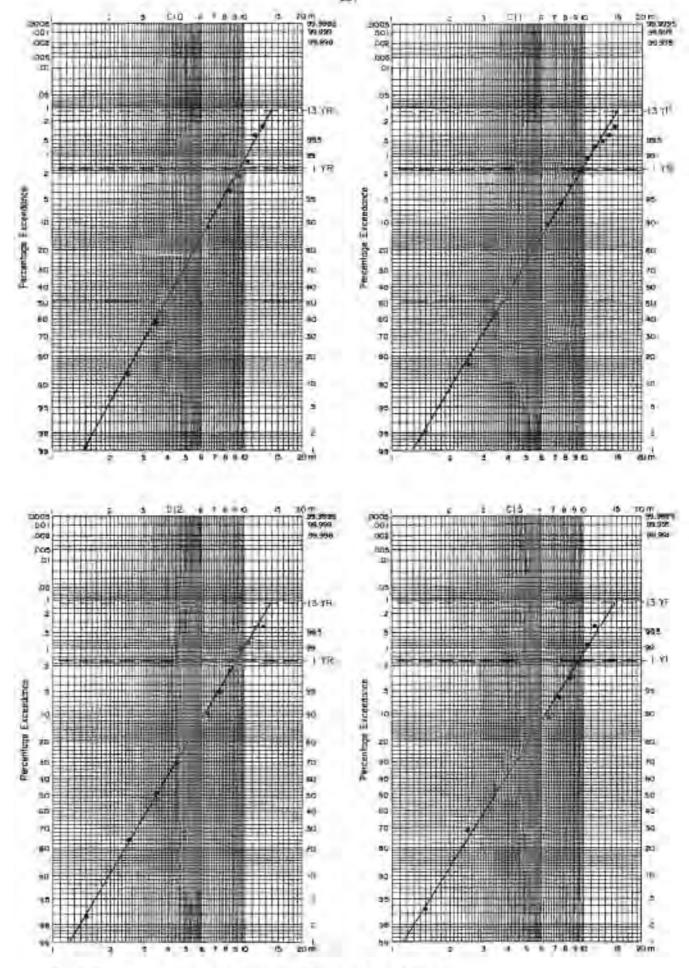
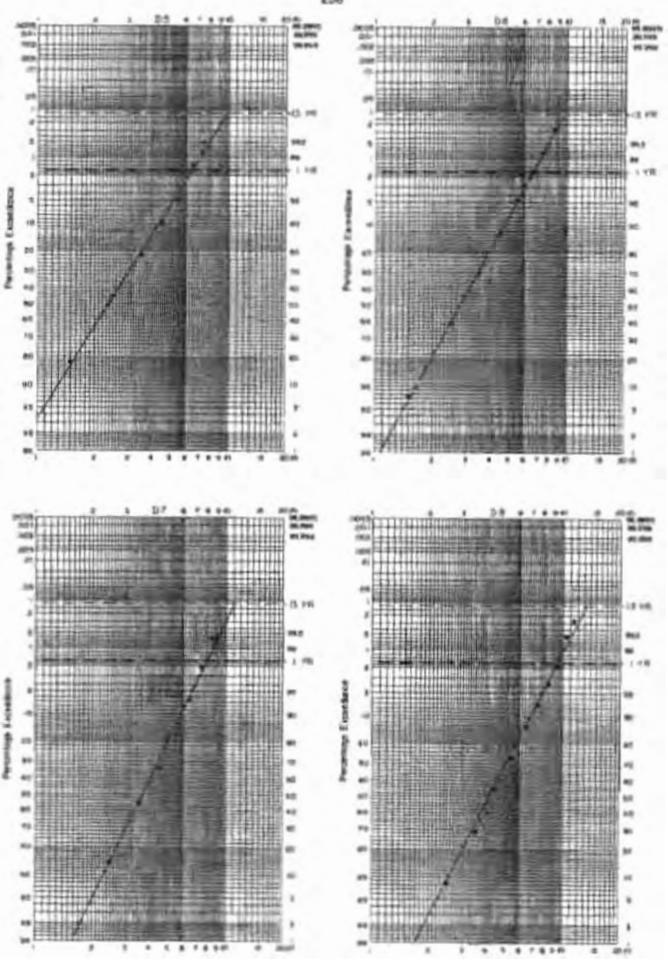


Figure 2) Monthly Wave Height Exceedance Distribution for December



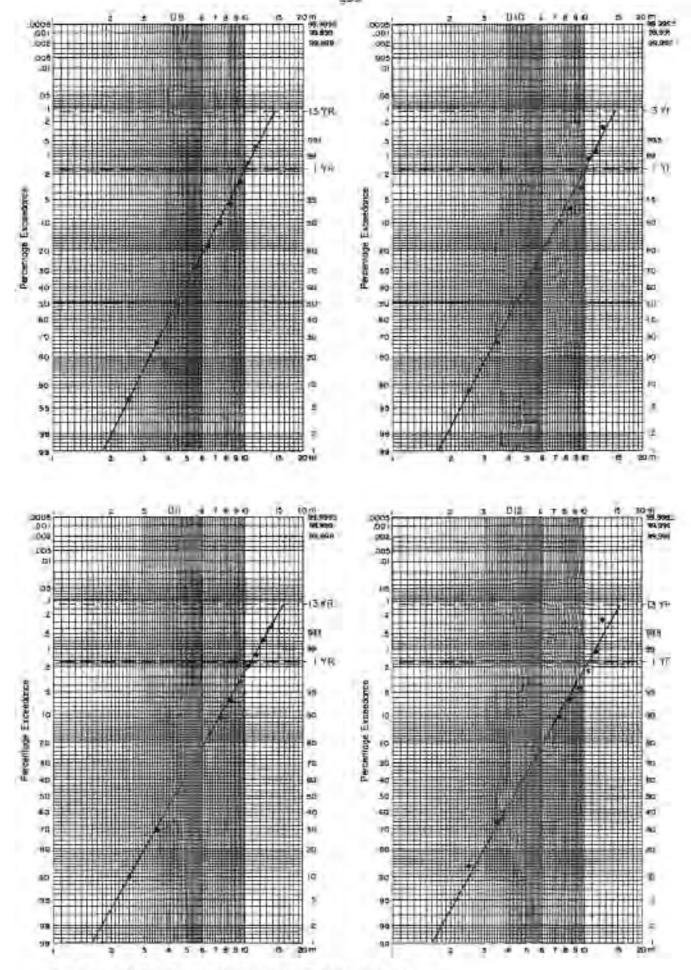


Figure 12. Monthly Wave Height Exceedance Distribution for December

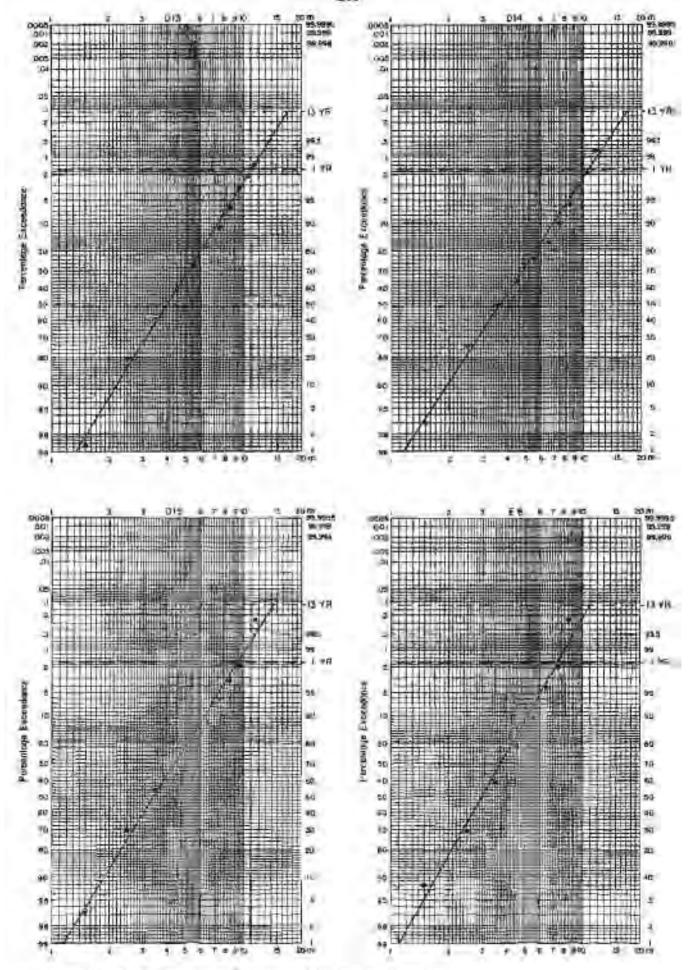


Figure 12m Monthly Wave Height Exceedance Distribution for December

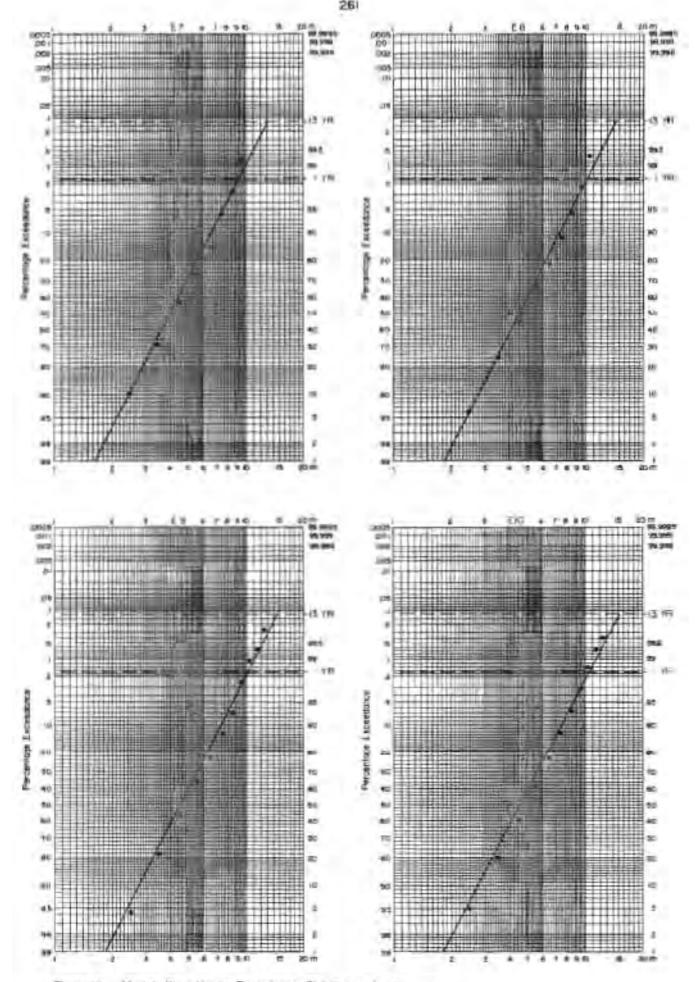


Figure 12n. Manimy Wave Height Exceedance Distribution for December.

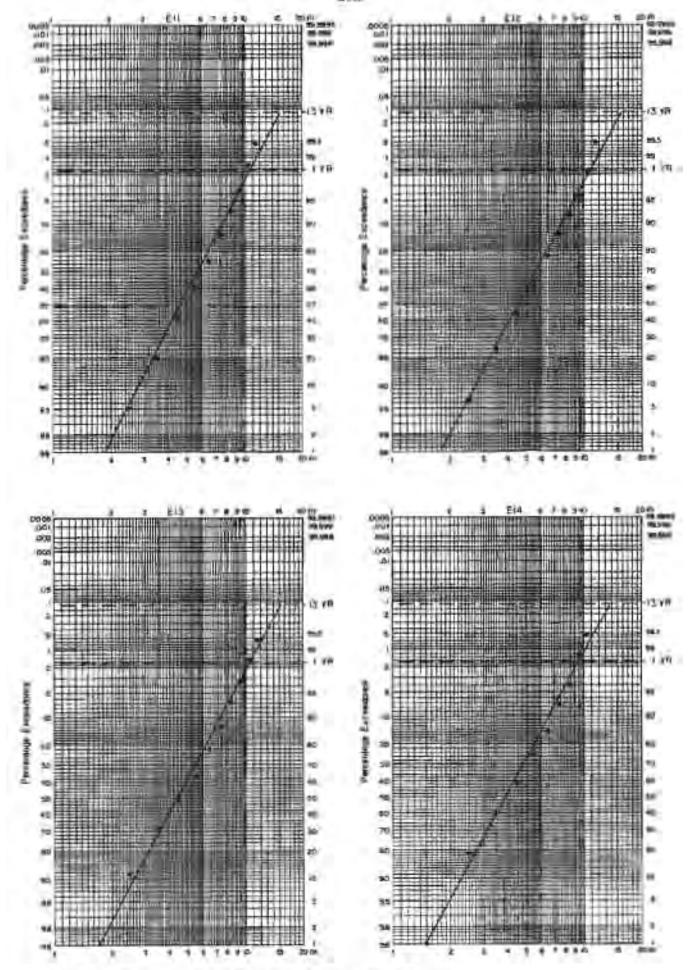


Figure 120. Monthly Wave Height Exceedance Distribution for December

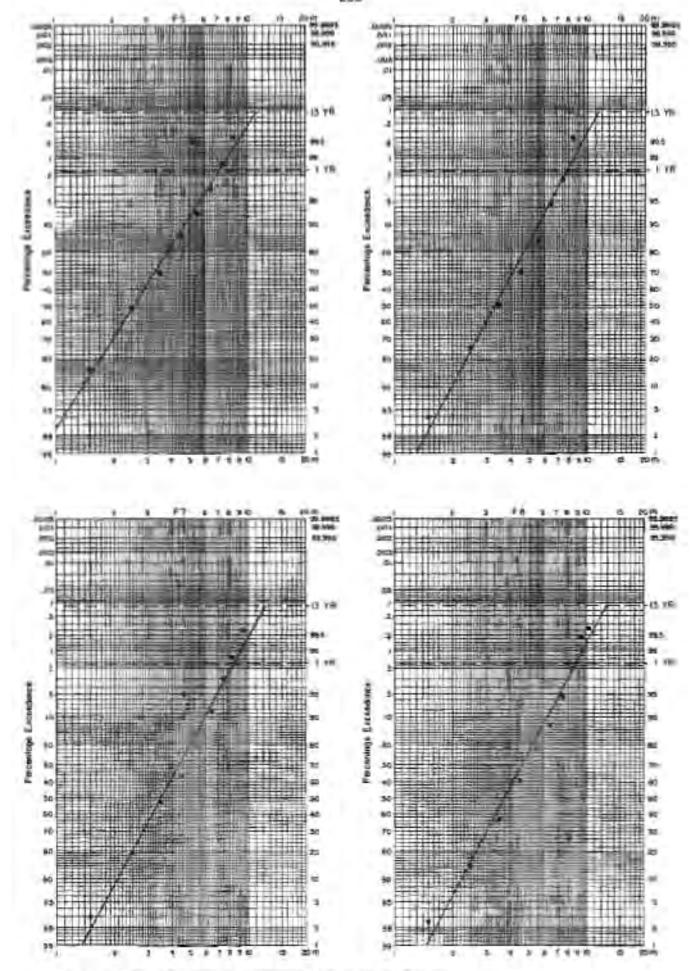


Figure 12 p. Marritily Wave Height Exceedance Distribution for December.

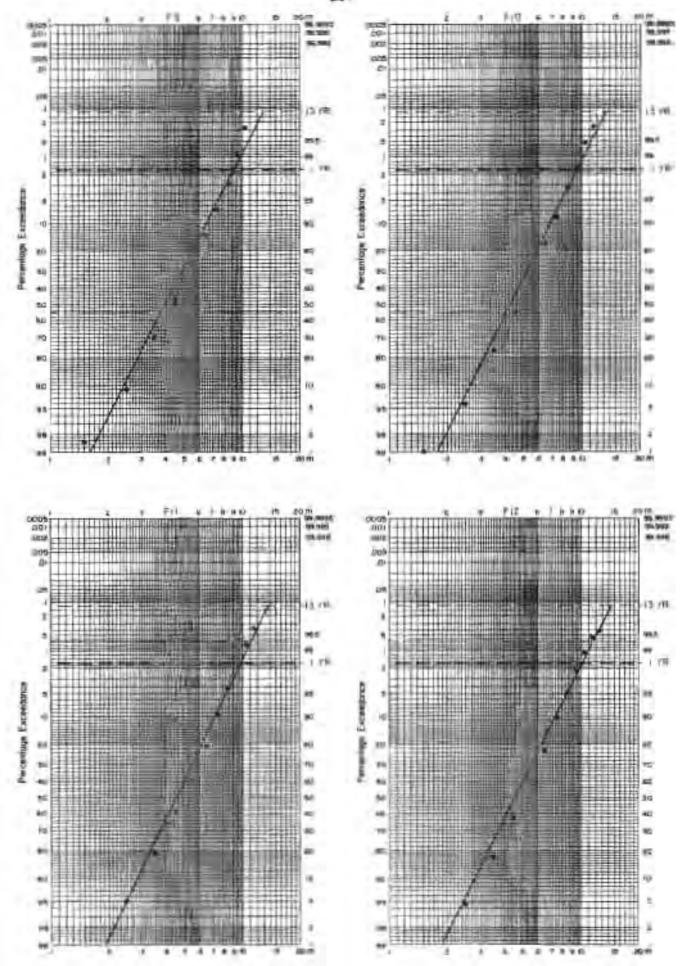


Figure ICq. Monthly Water Height Encentures Distribution for Discerdan

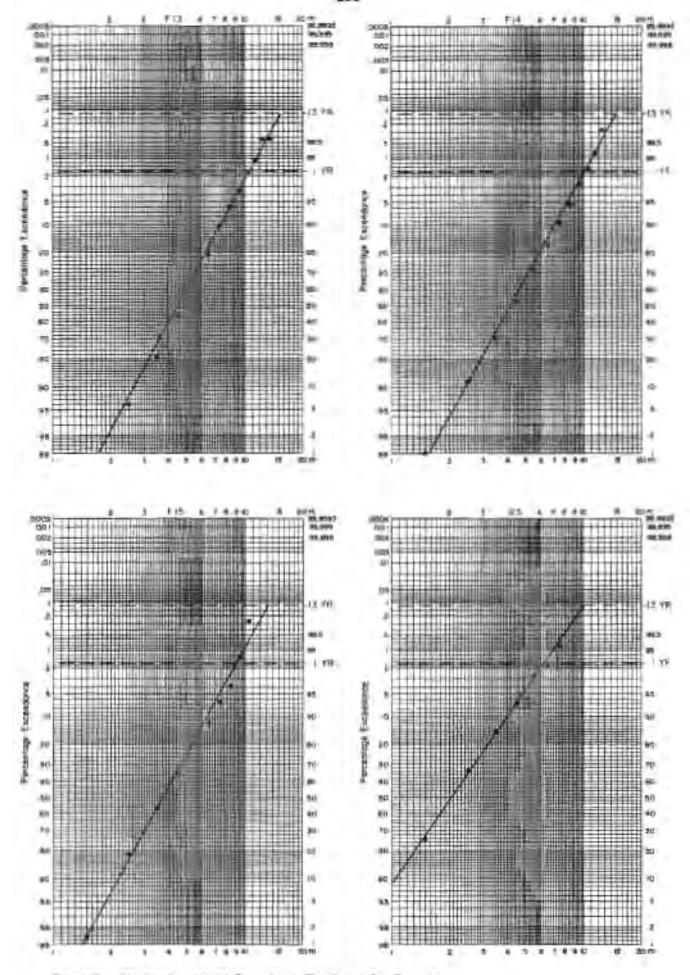


Figure (2) Monthly Wove Height Exceedance Distribution for December

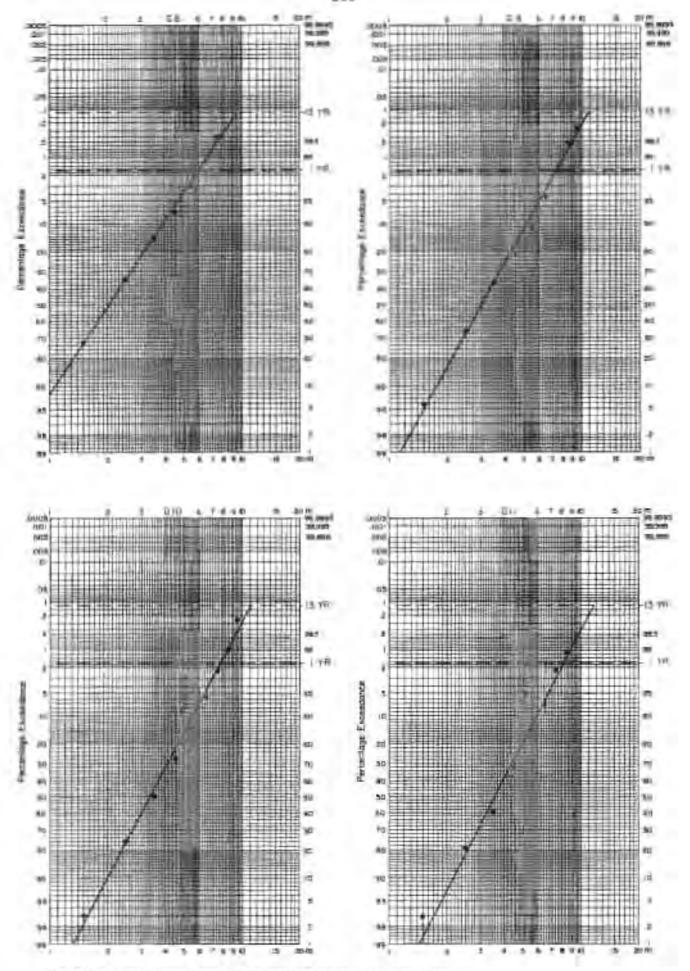


Figure 12.1 Monthly Wave Height Exceedance Distribution for December

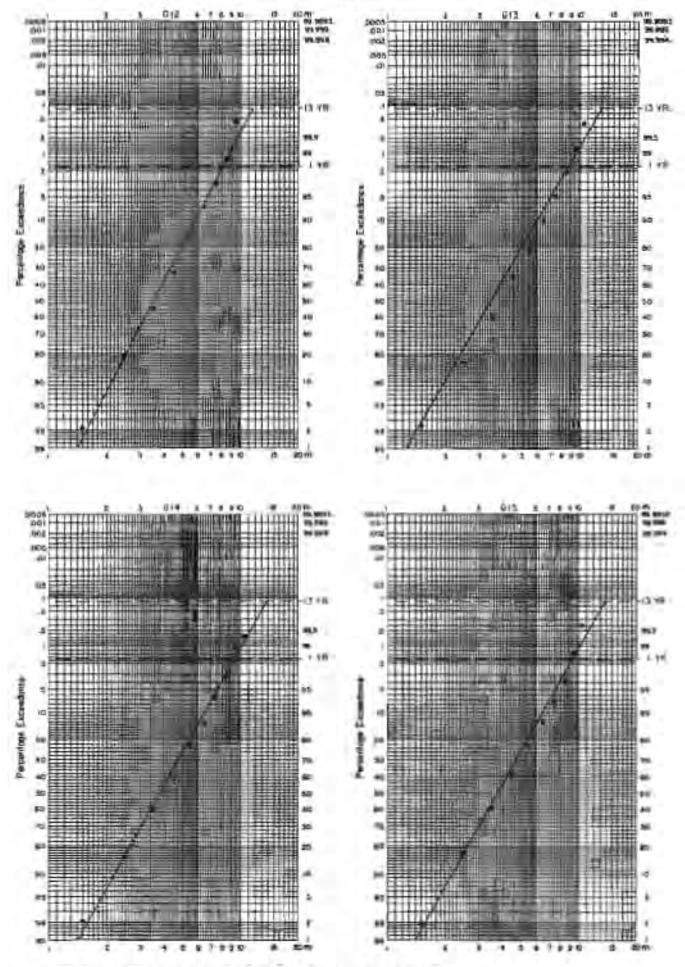


Figure (2) Morthly Wave Height Exceedance Distribution for December

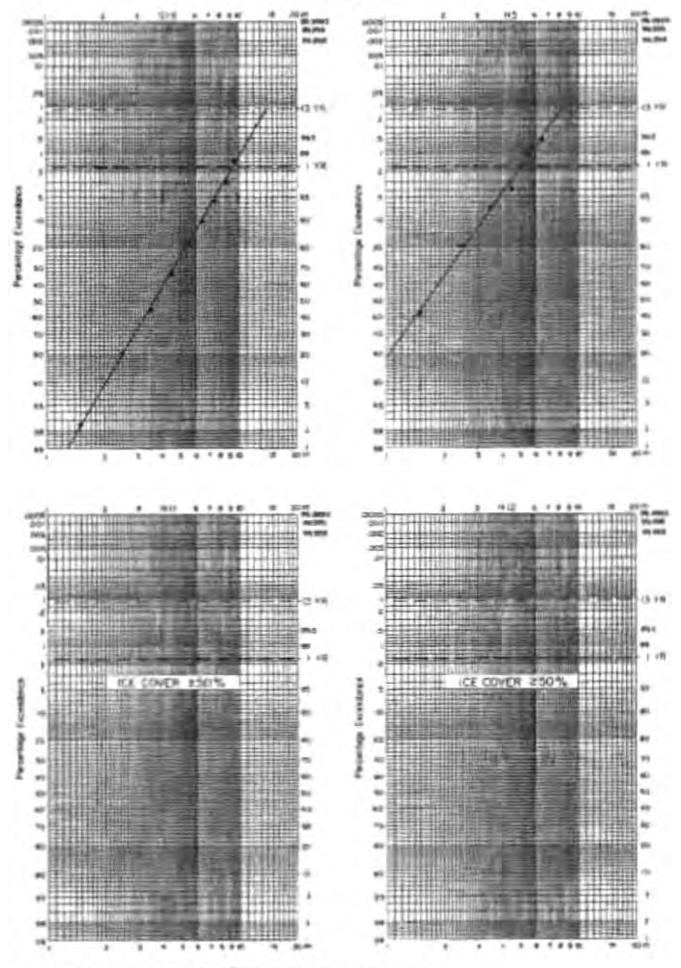


Figure 12.4. Monthly Rose Heigh Exceptions Distribution for Discertion

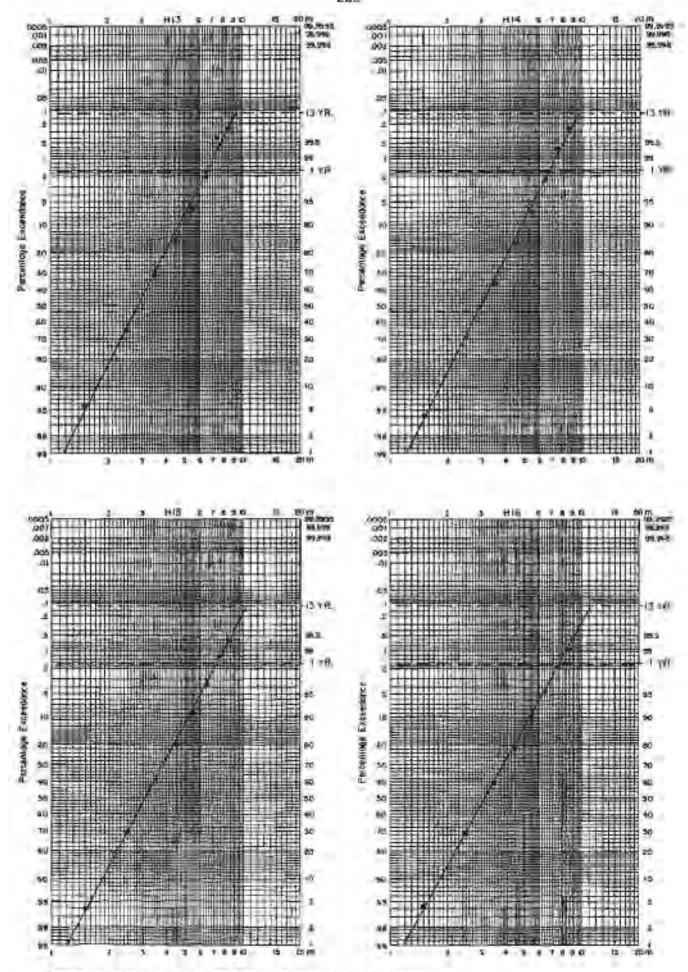


Figure 12v. Monthly Wave Height Exceedance Distribution by December



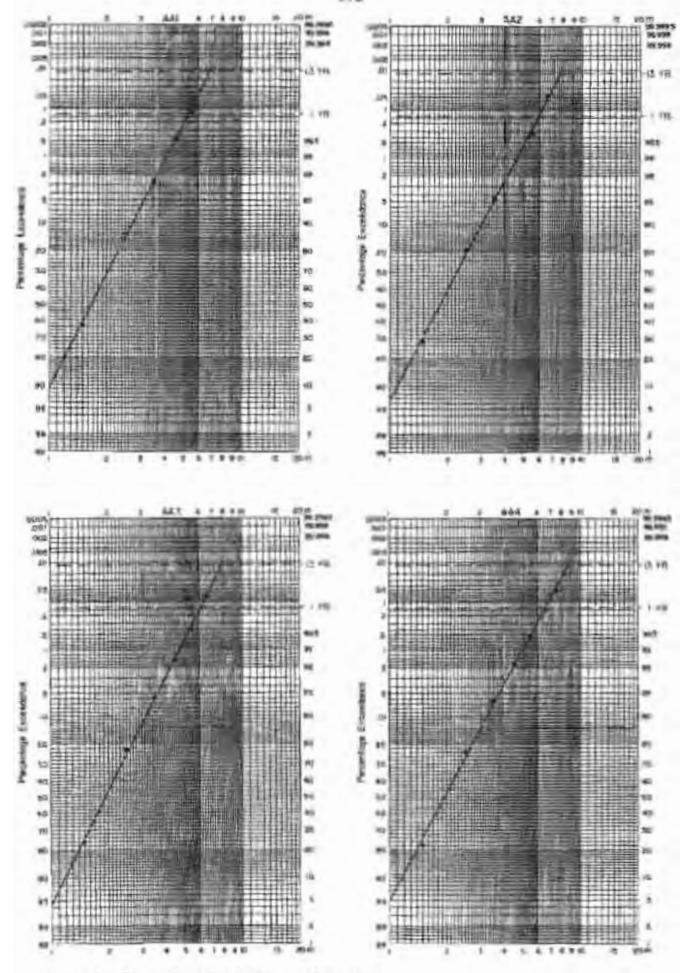


Figure Clis. 13 Years Wave Height Exceedance Distribution

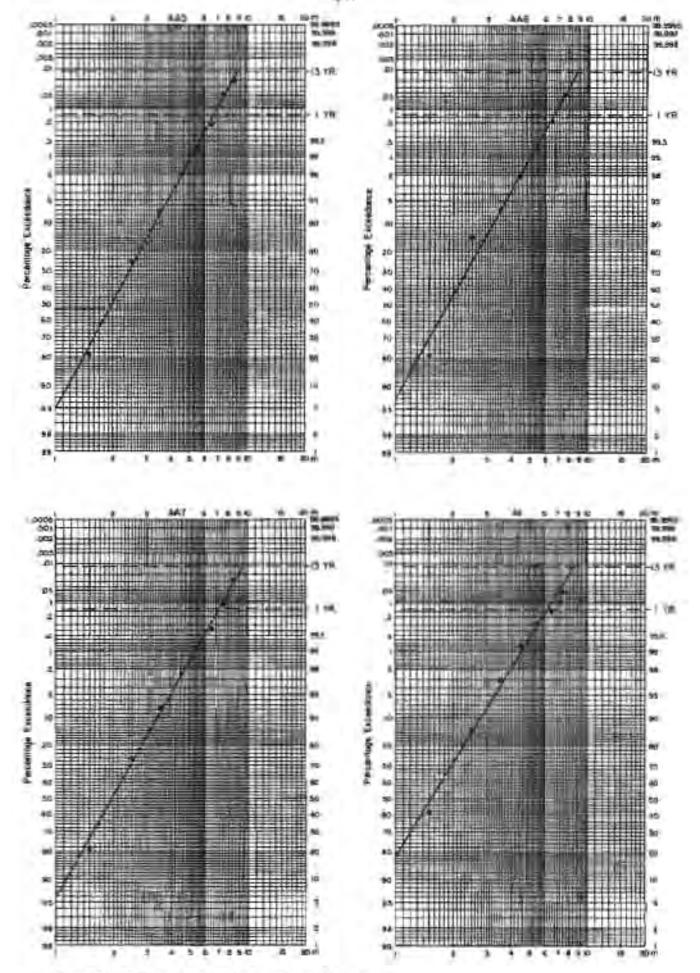


Figure ISh 13 Years Wove Height Excessionce Distribution

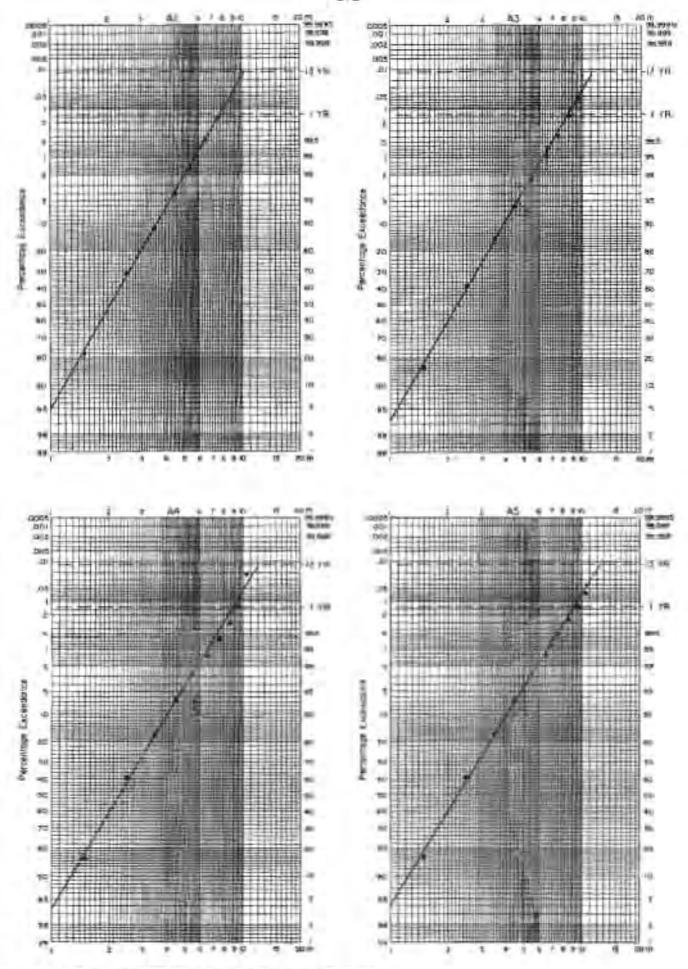


Figure (3c. 13 Years Wave Height Exceedance Distribution

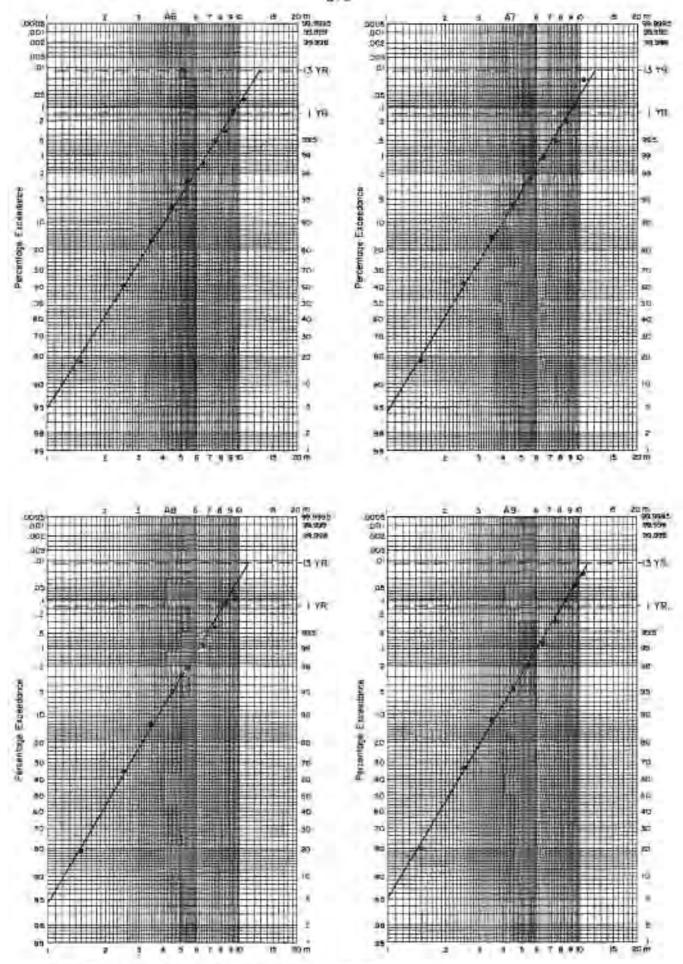


Figure Gd (3 Years Wave Heigh) Exceedance Distribution

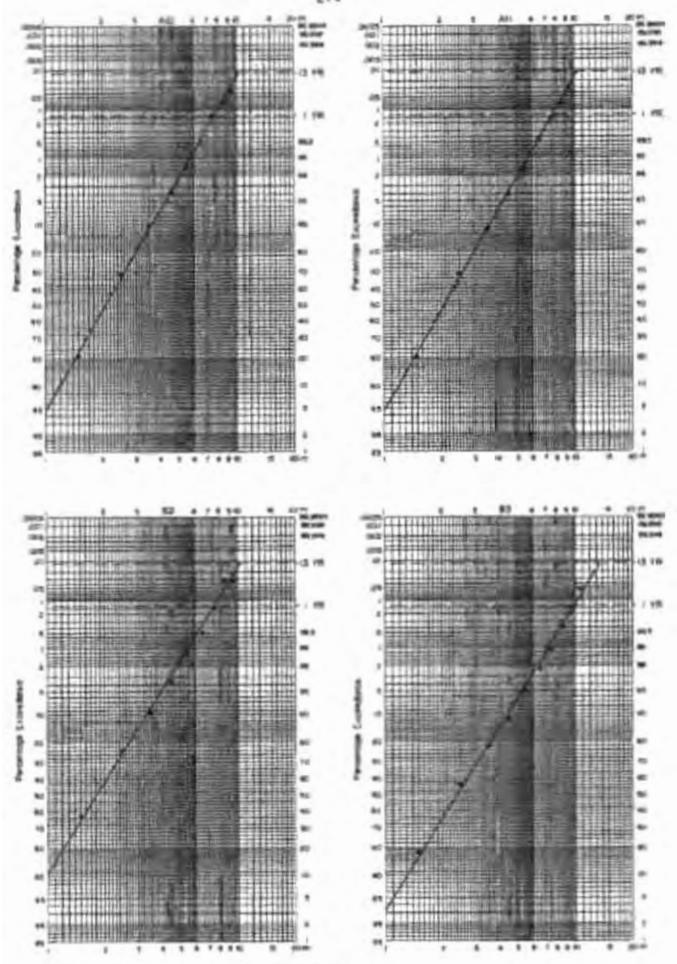


Figure Clie 12 faces Wove Height Excessionce Distribution

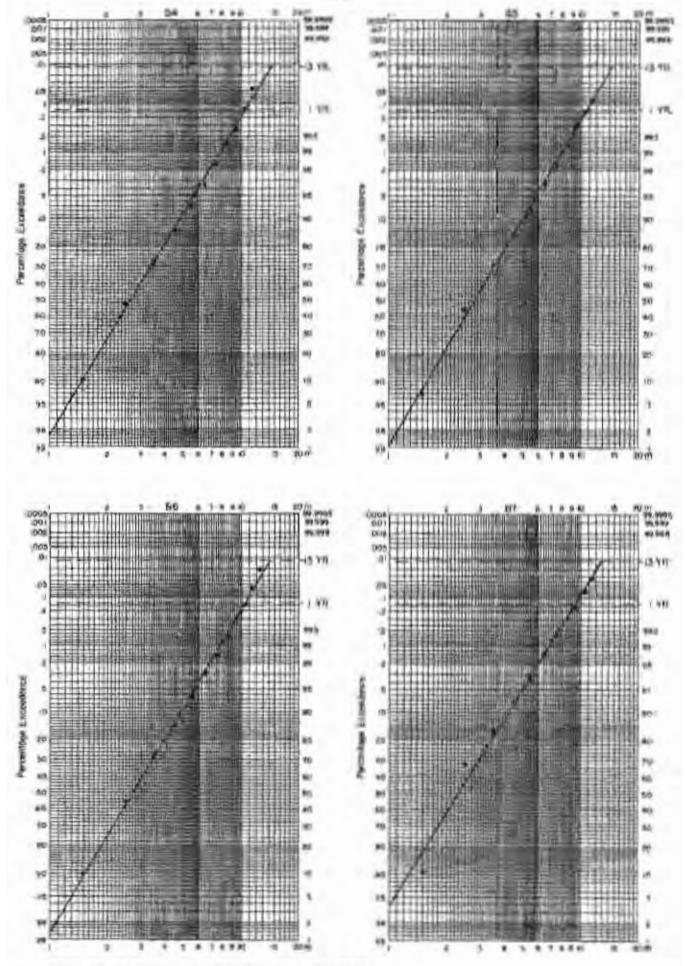


Figure GJ. (3 Years Wove Height Exceedescs Distribution

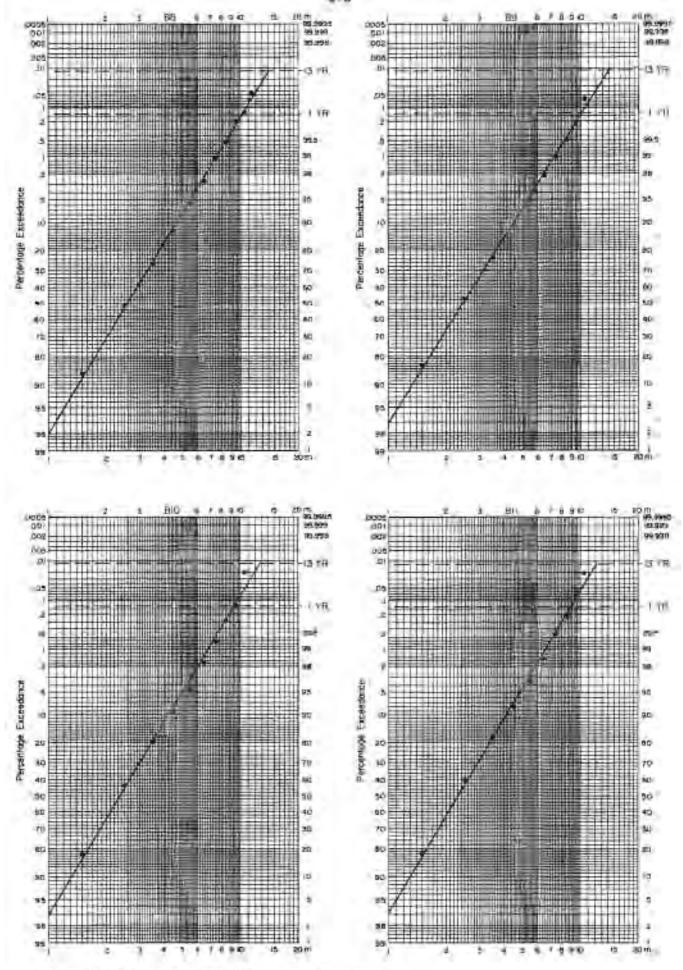


Figure 13g 13 Years Wave Height Exceedunce Distribution



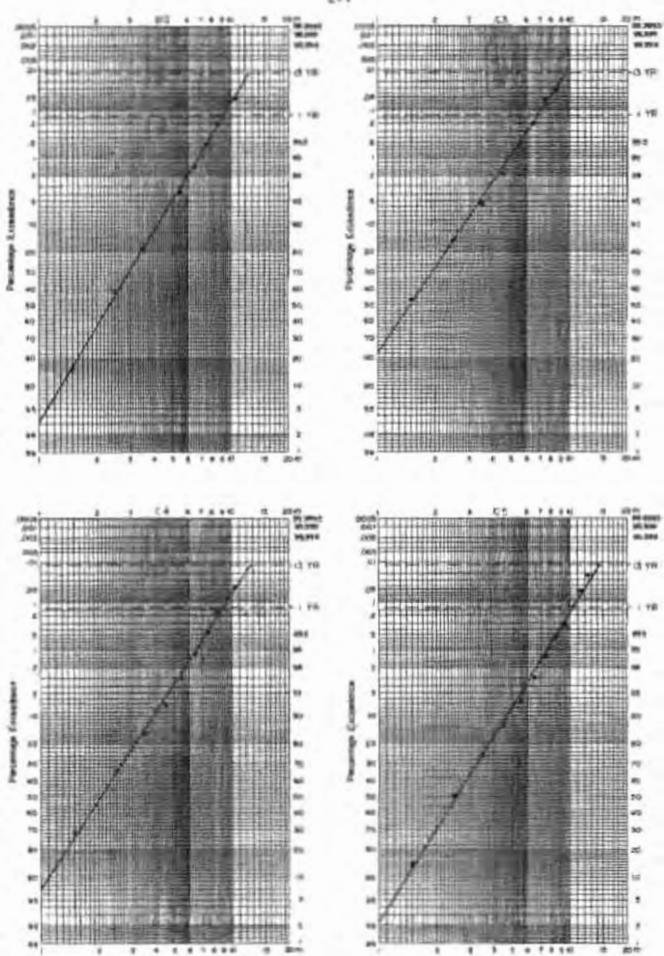


Figure 131: 13 Years Wave Height Exceedance Distribution

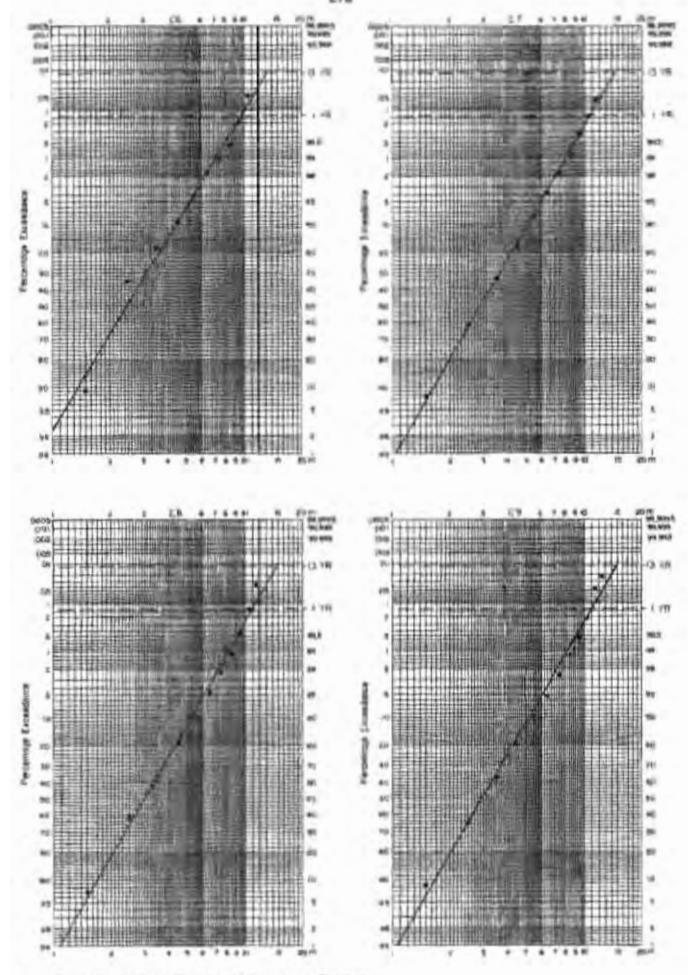


Figure Co. 13. Years Wave Height Exceedance Distribution

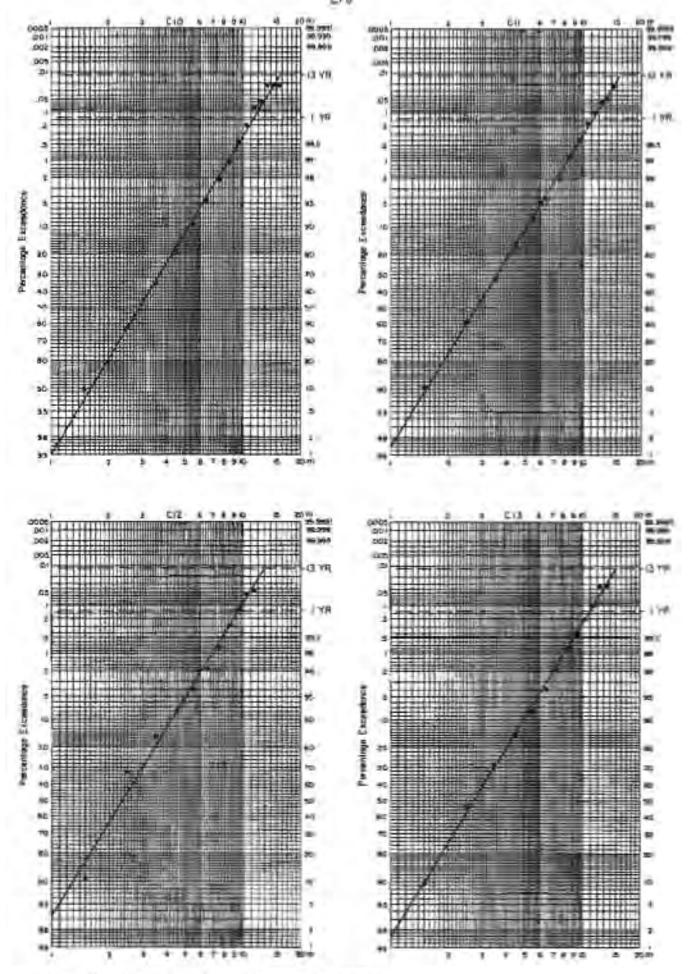


Figure (3) 15: 76015 Word Height Excredence Distribution

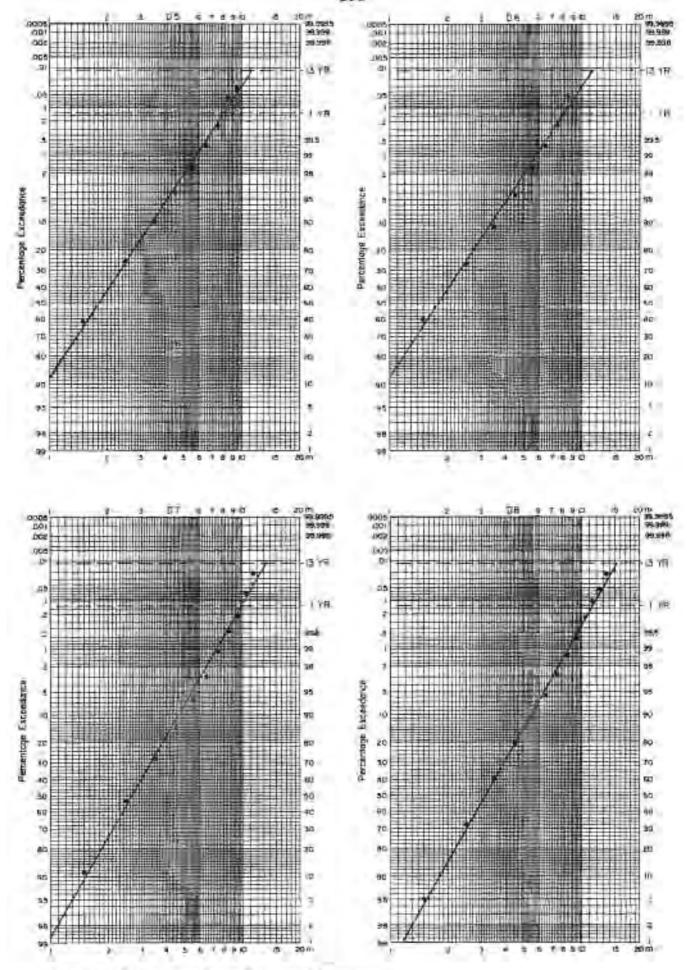


Figure 131. 13 Years Wave Height Estreatonice Distribution

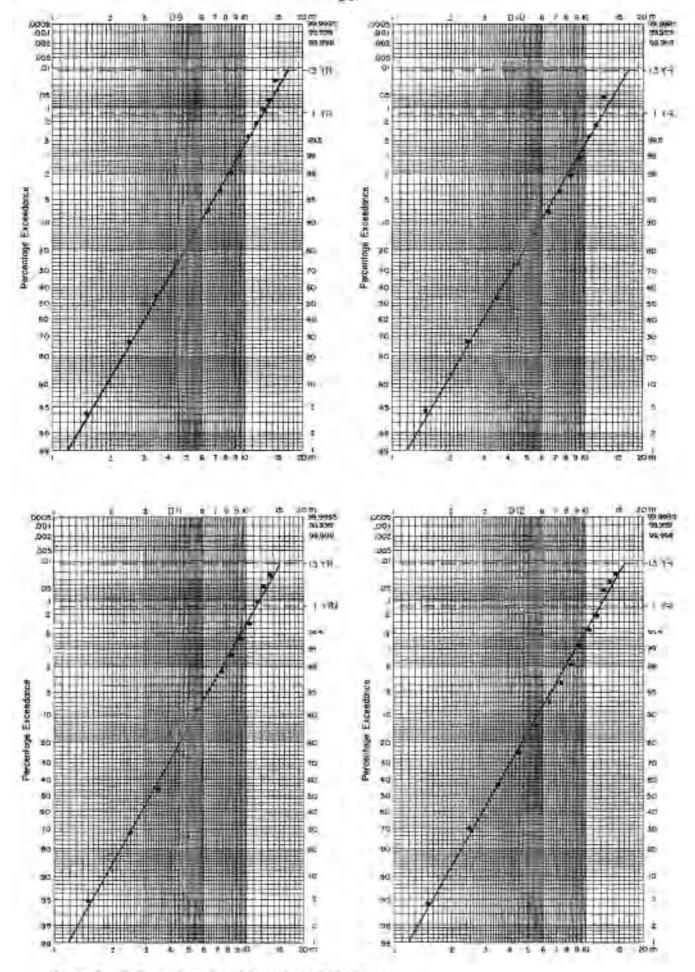


Figure 13: 13 Years Wave Height Exceedance Distribution

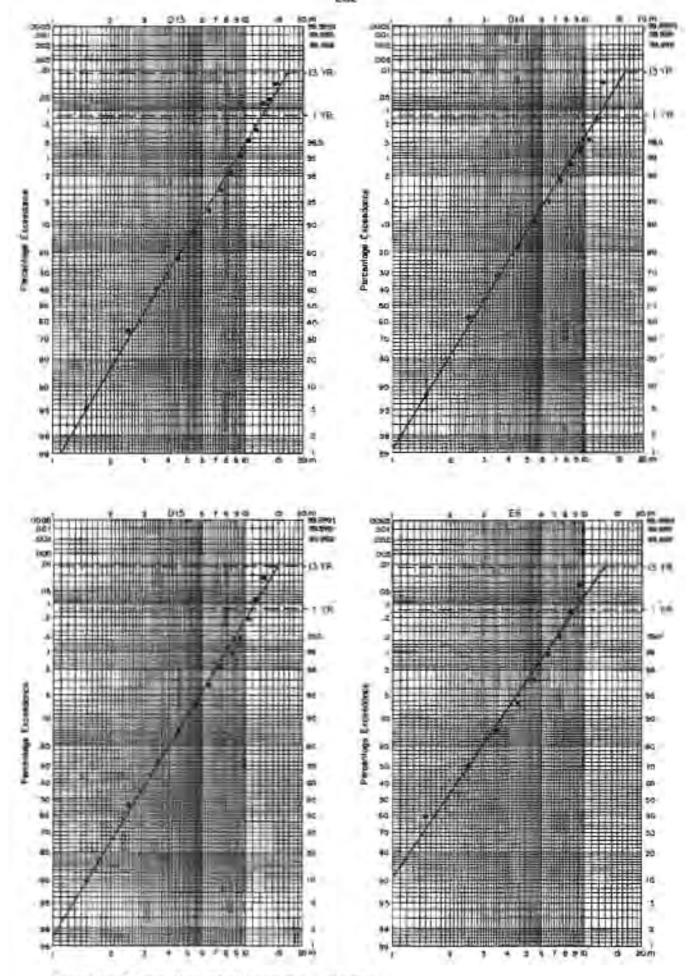


Figure 13m 13 Years Wave Height Exceedance Distribution

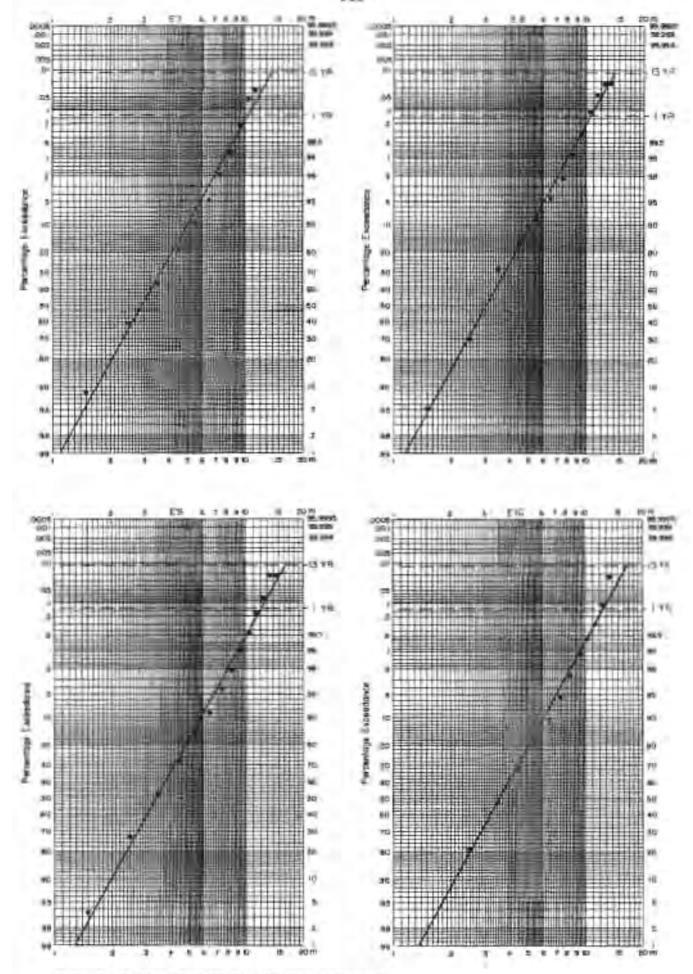


Figure (3), 13 Years Wave Height Exceedance Distribution

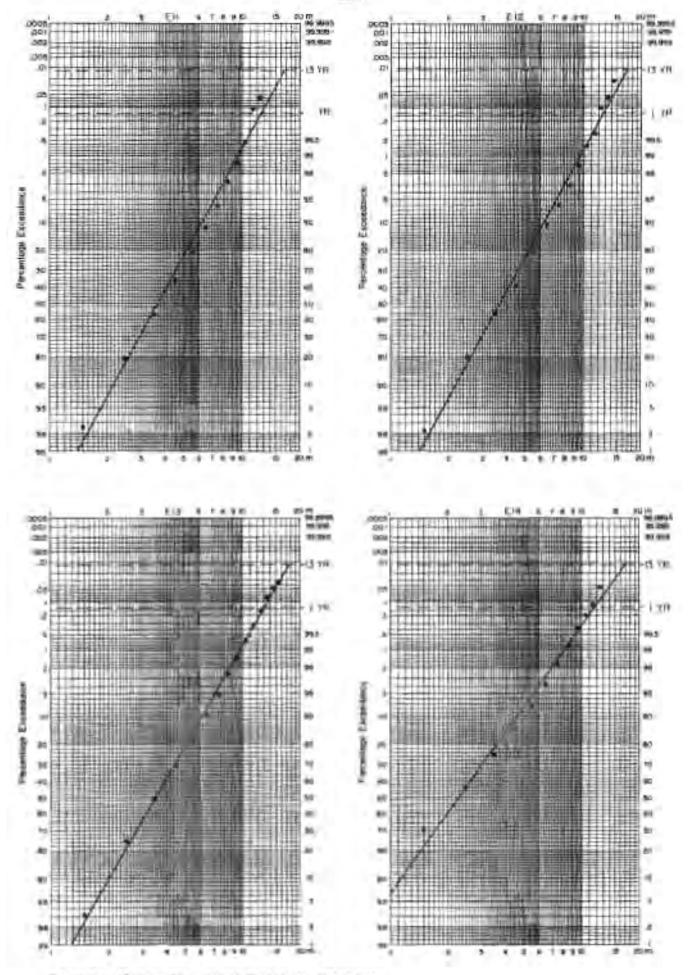


Figure (3p 13 Tears Wive Height Exceedance Distribution

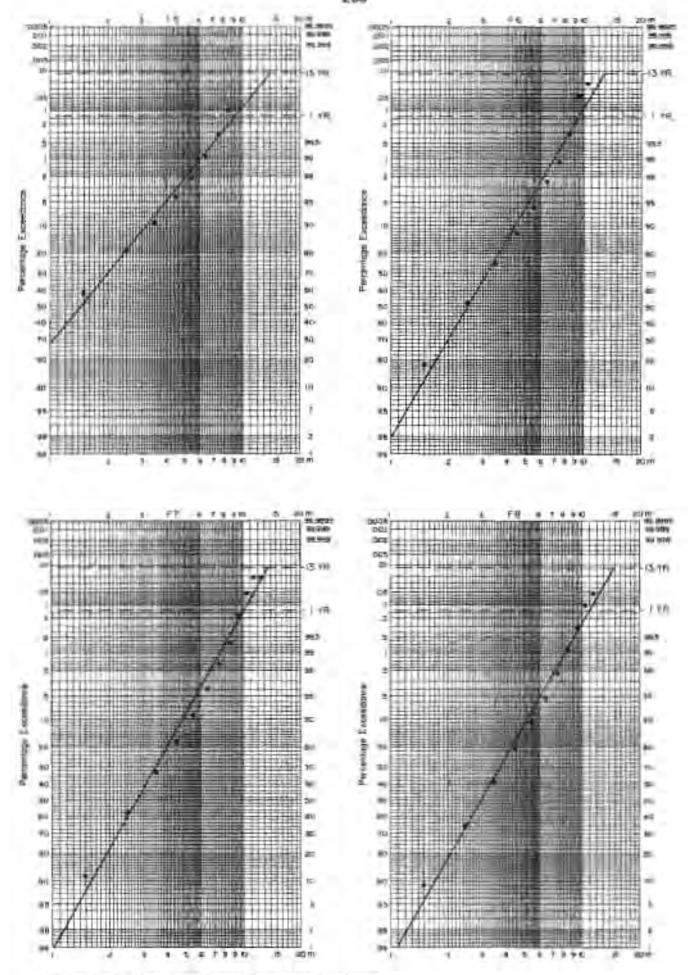
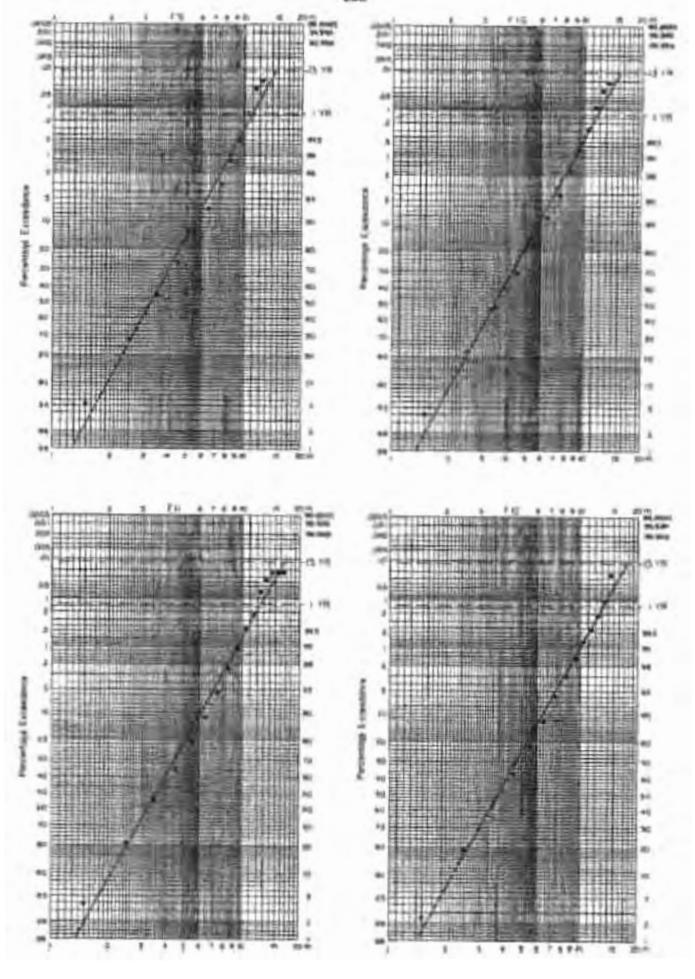


Figure 13p. 13 Years Wave Height Exceedance Distribution



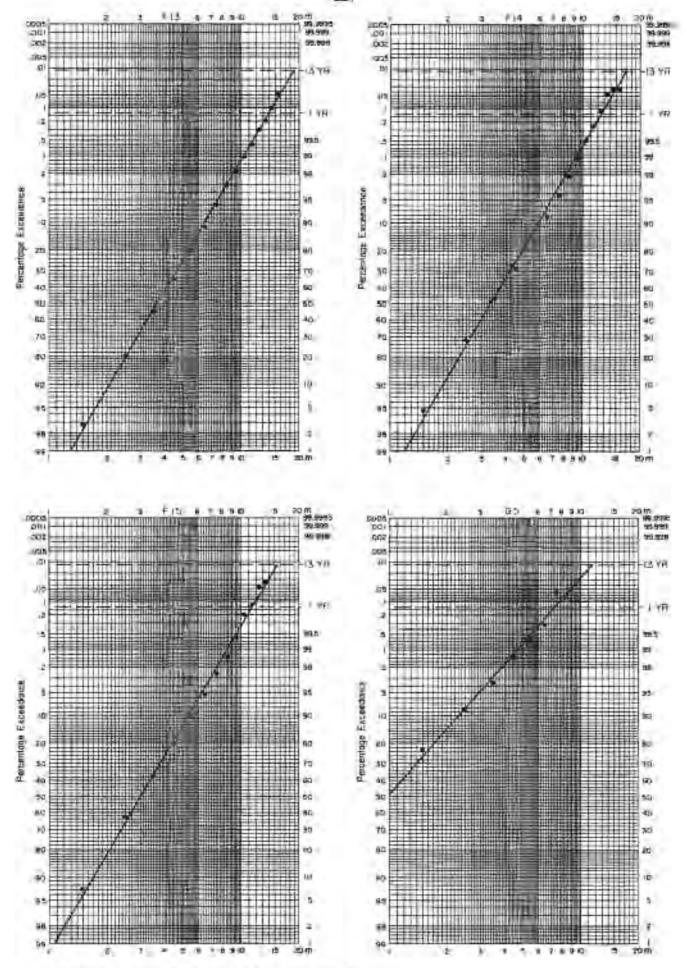


Figure 13: 13 Tears Wave Height Exceedance Distribution

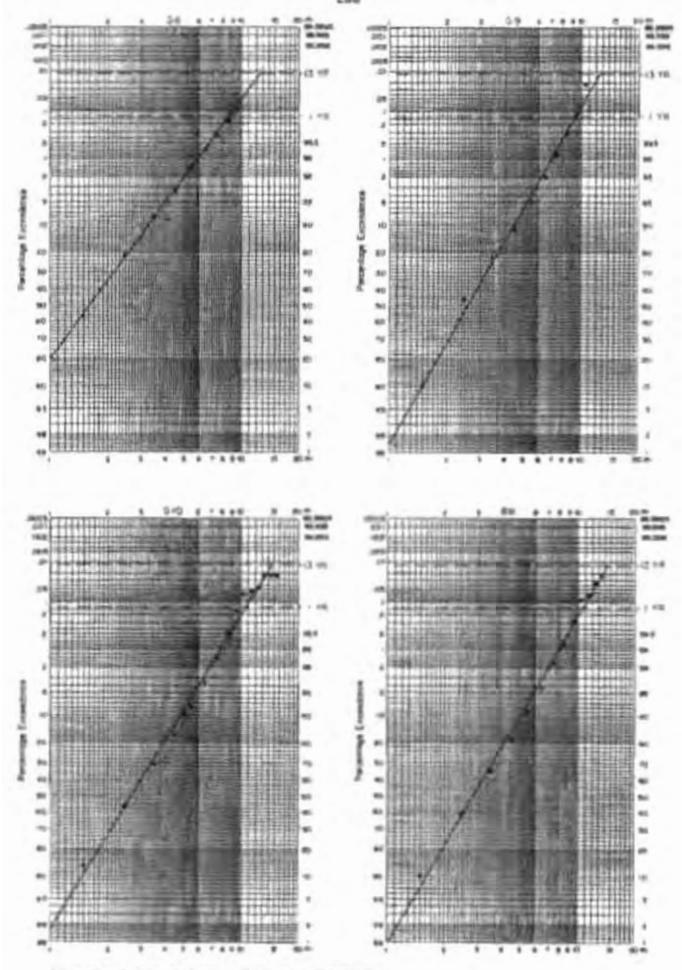
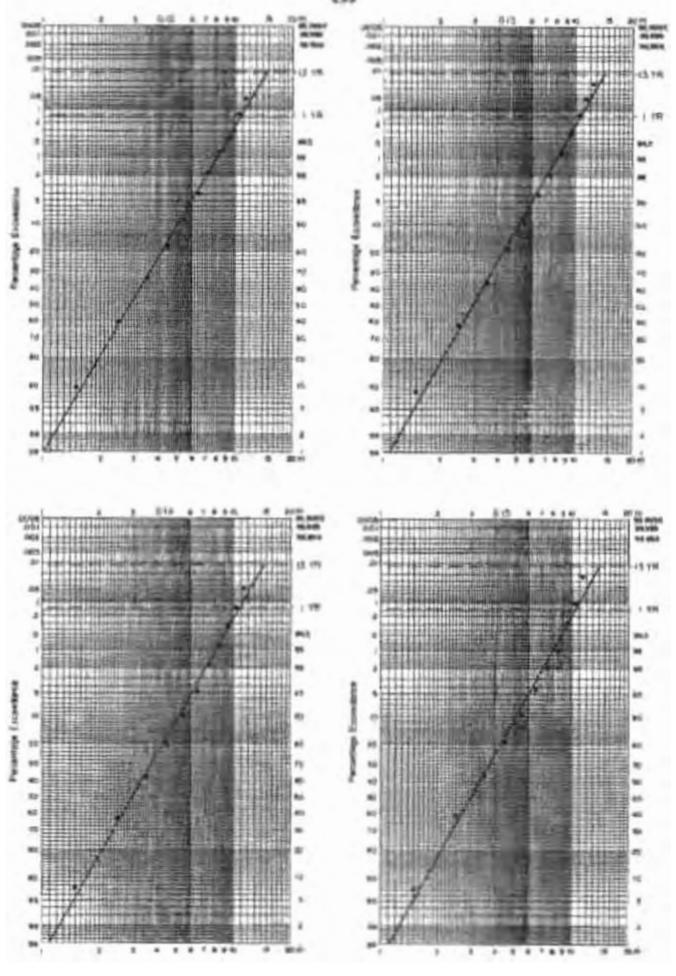


Figure Co. 13 Years Move recept Excentions Debriadors





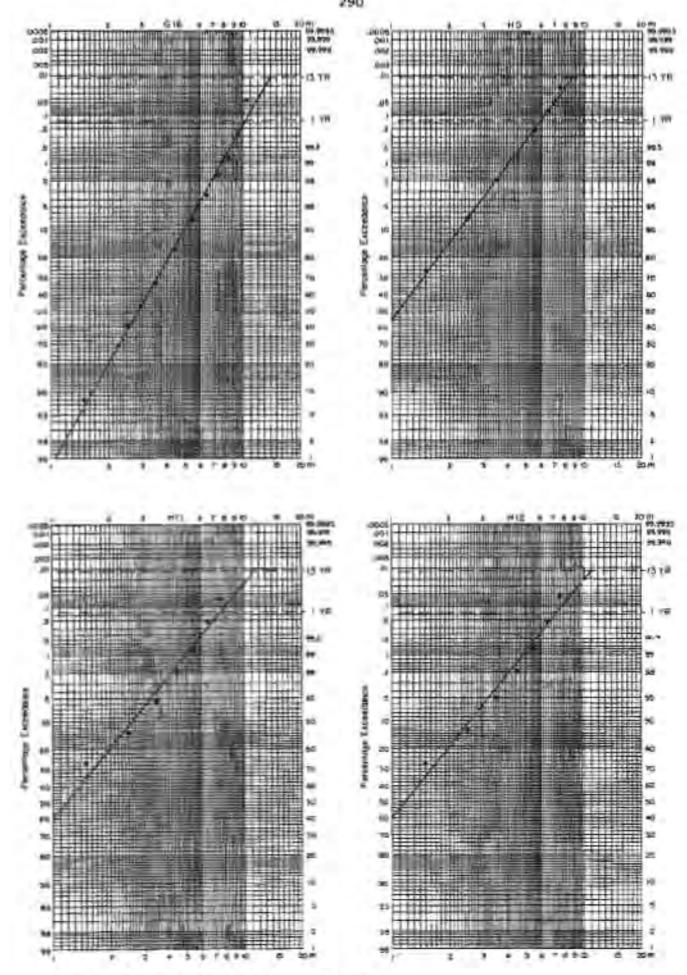


Figure (3.), 13 Years Wave Height Exceedance Dishibition

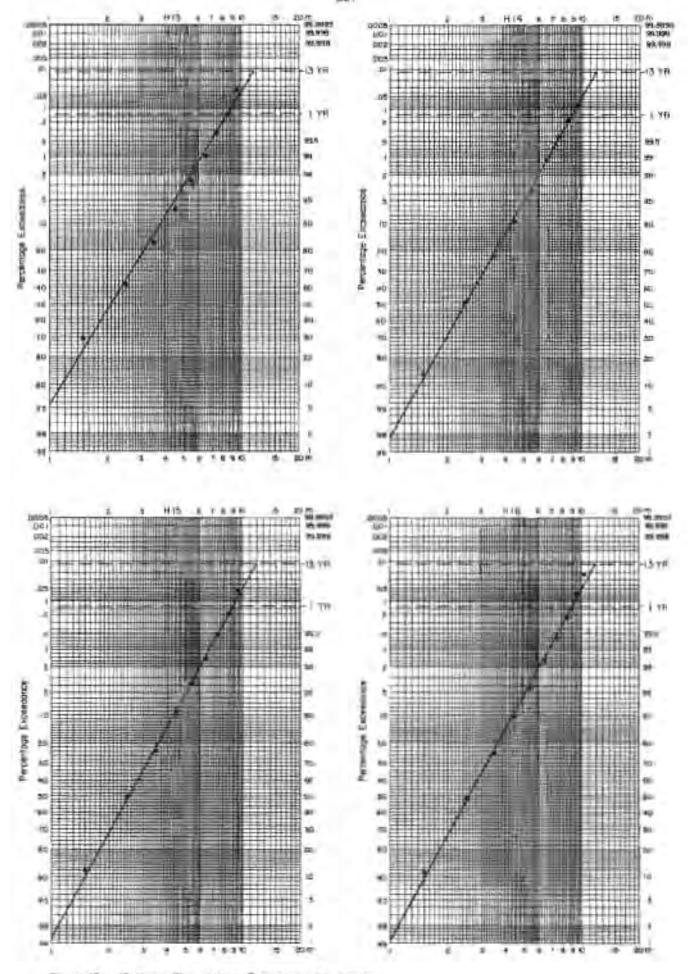


Figure 13v. 13 Years Wove Height Exceedance Distribution