NATIONAL INSTITUTE OF OCEANOGRAPHY

WORMLEY, GODALMING, SURREY

Graphs of Attenuation of Waves with Depth

by

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C O N T E N T S

GRAPHS OF ATTENUATION OF WAVES WITH DEPTH

These graphs have been computed from the classical hydrodynamical first order theory for a small-amplitude sinusoidal wave train. This theory neglects second order effects, but is sufficiently accurate for many purposes. Experimental work suggests that the pressure change at any given point in the water, due to waves travelling on the surface, is less than would be expected by calculation from the classical theory. Because of this, two scales are given on the "Attenuation Factor" ordinate; one is the theoretical scale, the other is derived from experimental work on the relationship between pressure changes on the sea bed and waves on the surface, measured on a sloping beach near to a coastline[1]. It seems reasonable to assume that, in similar situations, i.e. near to a coast, the same corrections to the pressure record as were revealed in these experiments can be applied to most coastal wave-pressure recordings. In these cases it is suggested that the experimental scale be used, and not the classical one. There is insufficient accurate information available on wave-pressure attenuation in deep water, away from a shore, to allow us to decide which scale to use, but the evidence which is available suggests that in this case also the pressure changes are less than would be expected by the simple theory.

The classical equation relating pressure change in the sea to waves on the surface is as follows -

$$\frac{A}{A_o} = \frac{\cosh \frac{2\pi}{\lambda}(d-z)}{\cosh \frac{2\pi d}{\lambda}}$$

where A_o is the wave height on the surface
A is the equivalent height of the pressure change
d is the depth to the sea bed
z is the depth of the instrument.

For instruments sited on the sea bed this reduces to -

$$\frac{A}{A_o} = \frac{1}{\cosh \frac{2\pi d}{\lambda}}$$

From experimental work on the validity of the latter equation, it was suggested that the equation be modified to -

$$\frac{A}{A_o} = \frac{1}{(0{\cdot}16 + \cosh \frac{2\pi d}{\lambda})}$$

It is from this equation that the "Experimental Results" scale on the graphs was derived.

NOTES ON THE PROGRAM

The computations for the graphs were done by means of a Mercury Autocode Program - R.A.E. Program No. 222.

R.A.E. Program 222

Description

The program computes the ratio A/A_o where -

$$\frac{A}{A_o} = \frac{\cosh (\frac{2\pi}{\lambda})(d-z)}{\cosh (\frac{2\pi d}{\lambda})}$$

and T which is given by

$$\frac{1}{T^2} = \left(\frac{g}{2\pi\lambda}\right) \tanh \left(\frac{2\pi d}{\lambda}\right)$$

Range

The program covers only values of $d/\lambda \leq 25$.

Data Tape

The data tape is headed by 3 parameters -

(i) T = No. of water depth values (d)
(ii) N = No. of wave length values (λ)
(iii) Q = No. of instrument depth values (z)

These are followed by (i) The water depth values
(ii) The wave length values
(iii) The instrument depth values

Output

The results are tabulated in blocks corresponding to the data used to obtain the answers, i.e.

Z	A/A_o		T		B	D
5	3·50990564,	-1	2·42052923,	0	30	25
20	1·70315799,	-2				
30	*					
5	5·98184855,	-1	3·44131307,	0	60	
20	1·65478023,	-1				
30	*					
5	3·50919833,	-1	2·42046069,	0	30	45
20	1·51650490,	-2				
30	1·87092991,	-3				
5	5·92473270,	-1	3·42332454,	0	60	
20	1·23790043,	-1				
30	2·04845317,	-1				

The results are given in floating point form as they cover a wide range. As it is impossible for the instruments to be placed at a depth greater than the water depth, the program arranges for an asterisk to be printed instead of calculating an answer.

The graphs in this report are only a selection of the computations which have been made. The results of this work are held at the National Institute of Oceanography, and may be referred to at any time. The values of water depths, instrument depths and wavelengths which were used in the computations are listed in Table I.

Acknowledgement

The authors would like to acknowledge the help received from their colleagues in the preparation of this report.

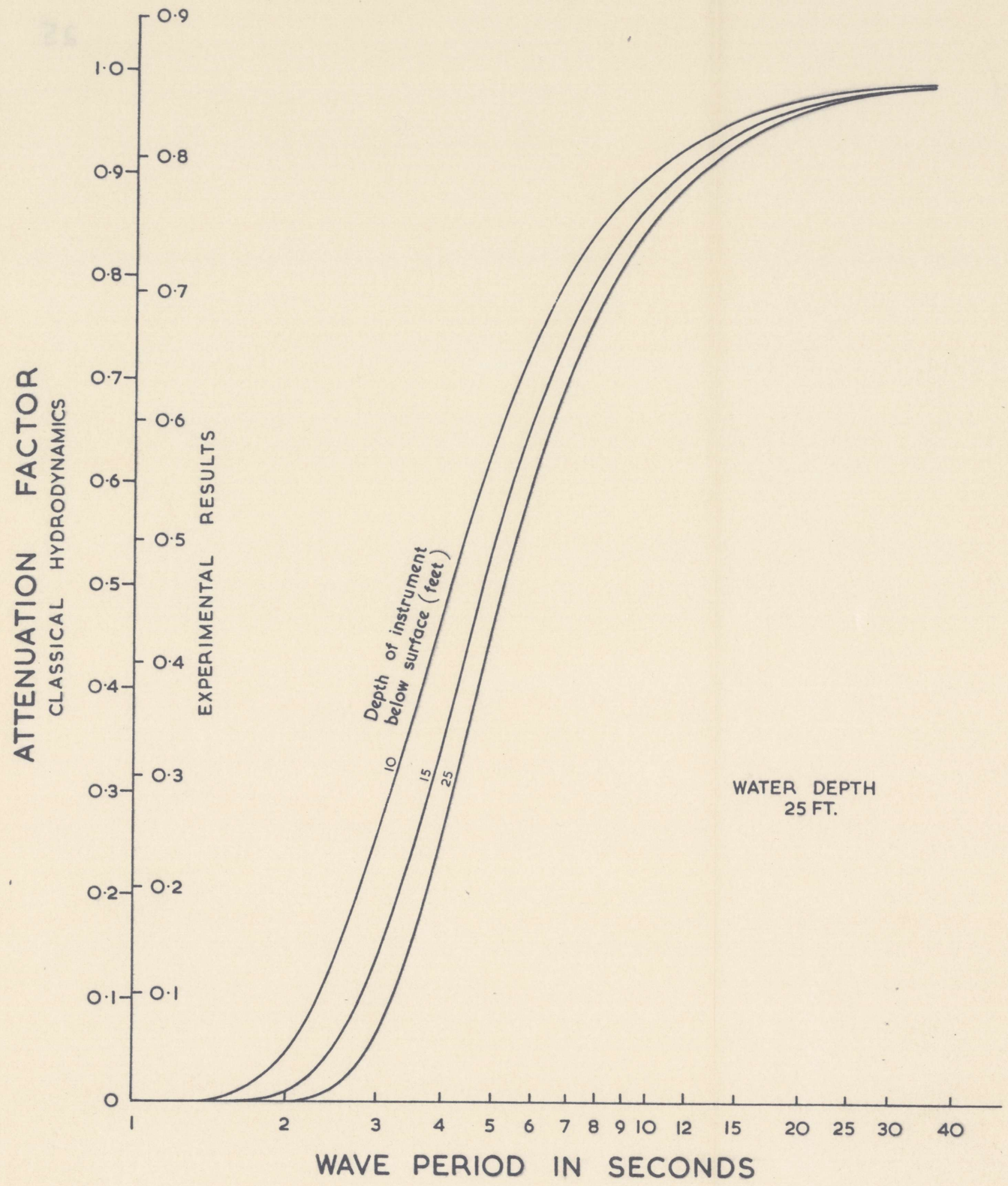
Reference

[1] Draper, L. 1957 Attenuation of sea waves with depth. La Houille Blanche 12, 926-931.

TABLE I

Attenuation factors are calculated for the following depths and wave lengths. Figures available are marked with an asterisk.

Water depth D ft.	Instrument depth z ft.	Wave-length B ft.												
		5	10	20	30	40	60	100	150	200	300	500	1000	2000
10	5(5)10	*	*	*	*	*	*	*	*	*	*	*	*	*
15	5(5)15	*	*	*	*	*	*	*	*	*	*	*	*	*
20	5(5)20	*	*	*	*	*	*	*	*	*	*	*	*	*
25	5(5)25	*	*	*	*	*	*	*	*	*	*	*	*	*
30	5(5)30	*	*	*	*	*	*	*	*	*	*	*	*	*
35	5(5)35	*	*	*	*	*	*	*	*	*	*	*	*	*
40	5(5)40	*	*	*	*	*	*	*	*	*	*	*	*	*
45	5(5)45	*	*	*	*	*	*	*	*	*	*	*	*	*
50	5(5)50	*	*	*	*	*	*	*	*	*	*	*	*	*
60	5(5)50(10)60	*	*	*	*	*	*	*	*	*	*	*	*	*
70	5(5)50(10)60	*	*	*	*	*	*	*	*	*	*	*	*	*
80	5(5)50(10)60(20)80	*	*	*	*	*	*	*	*	*	*	*	*	*
100	5(5)50(10)60(20)100	*	*	*	*	*	*	*	*	*	*	*	*	*
120	5(5)50(10)60(20)120	*	*	*	*	*	*	*	*	*	*	*	*	*
150	5(5)50(10)60(20)120		*	*	*	*	*	*	*	*	*	*	*	*
200	5(5)50(10)60(20)120		*	*	*	*	*	*	*	*	*	*	*	*
250	5(5)50(10)60(20)120		*	*	*	*	*	*	*	*	*	*	*	*
300	5(5)50(10)60(20)120			*	*	*	*	*	*	*	*	*	*	*



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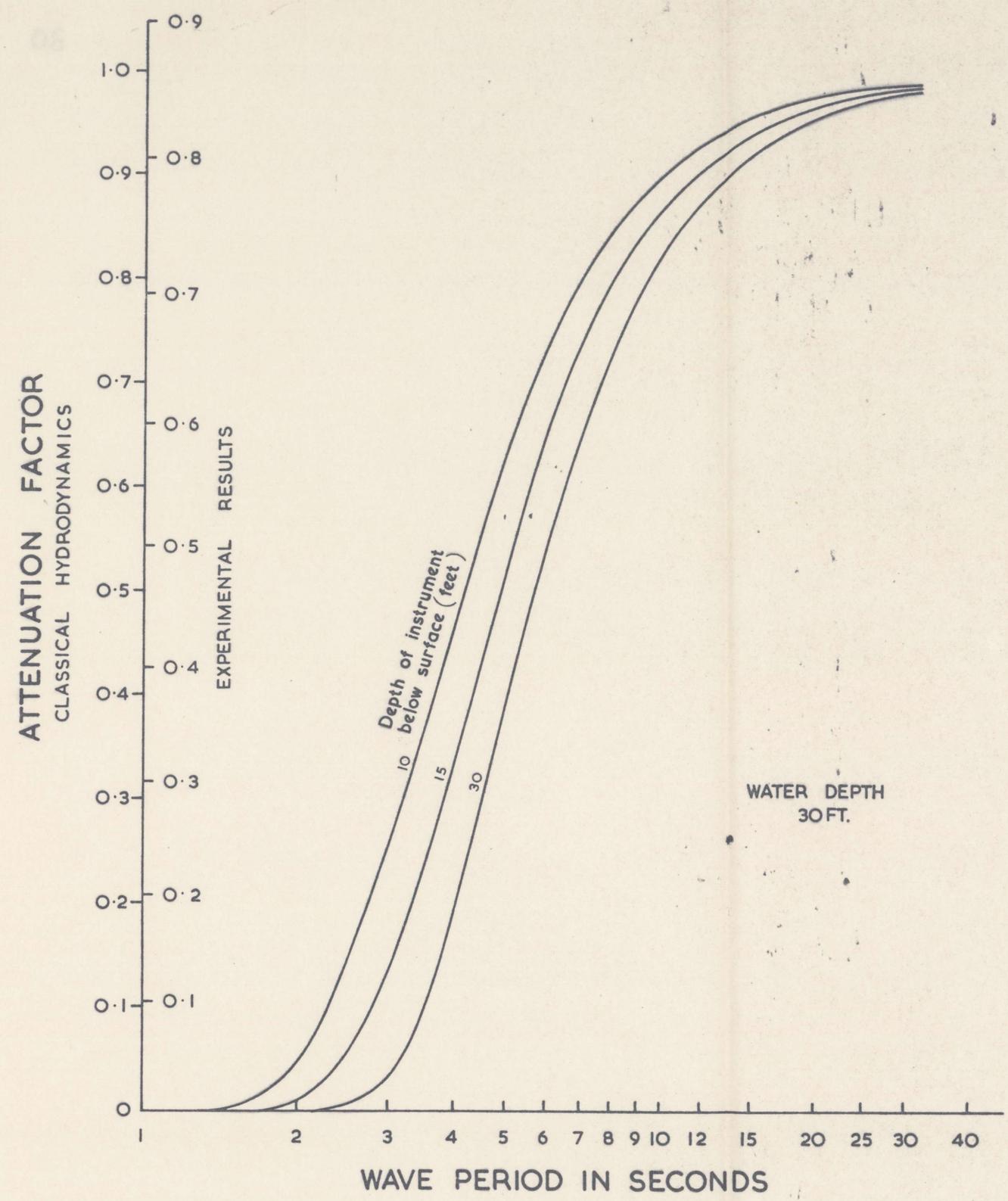

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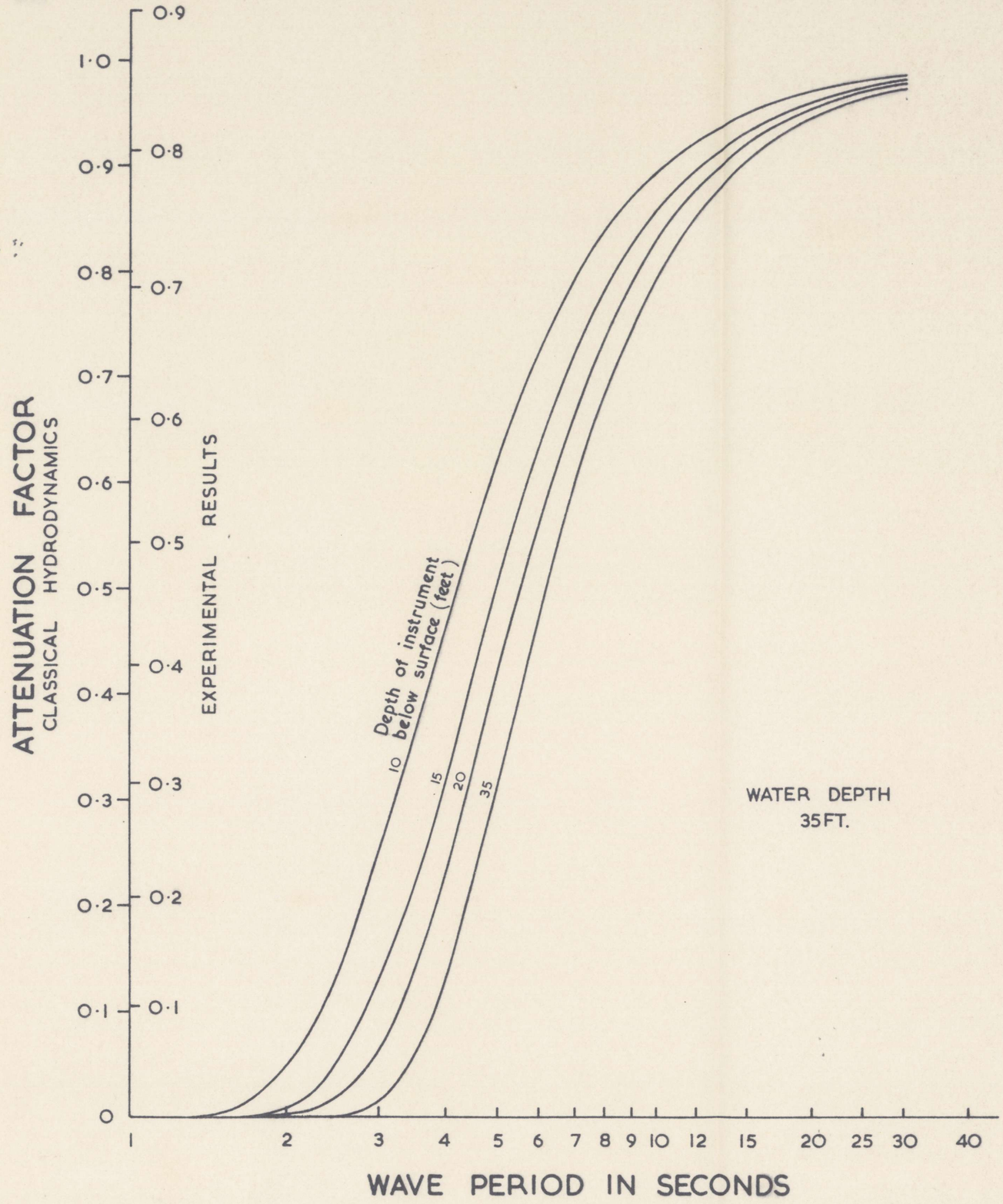
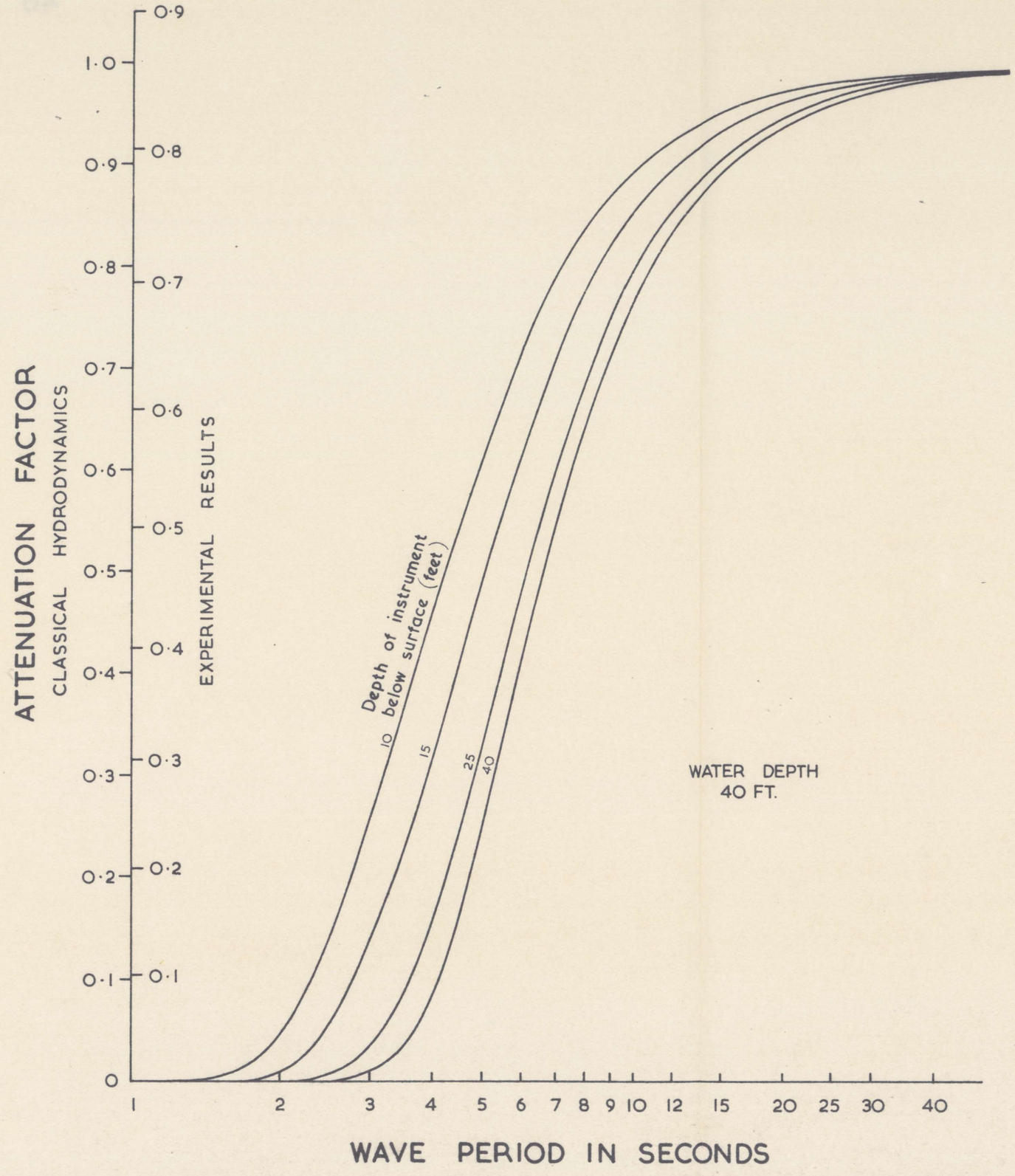
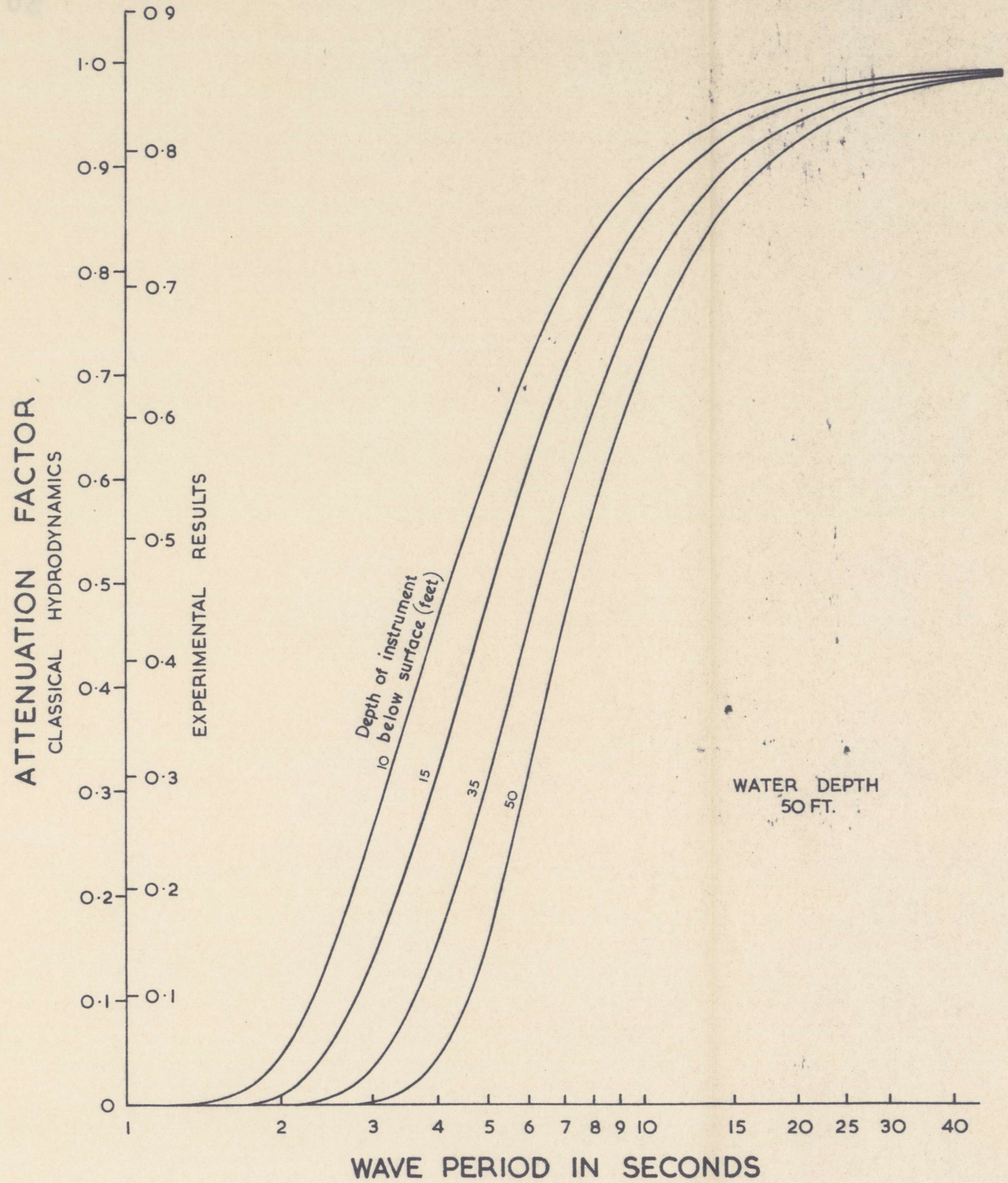
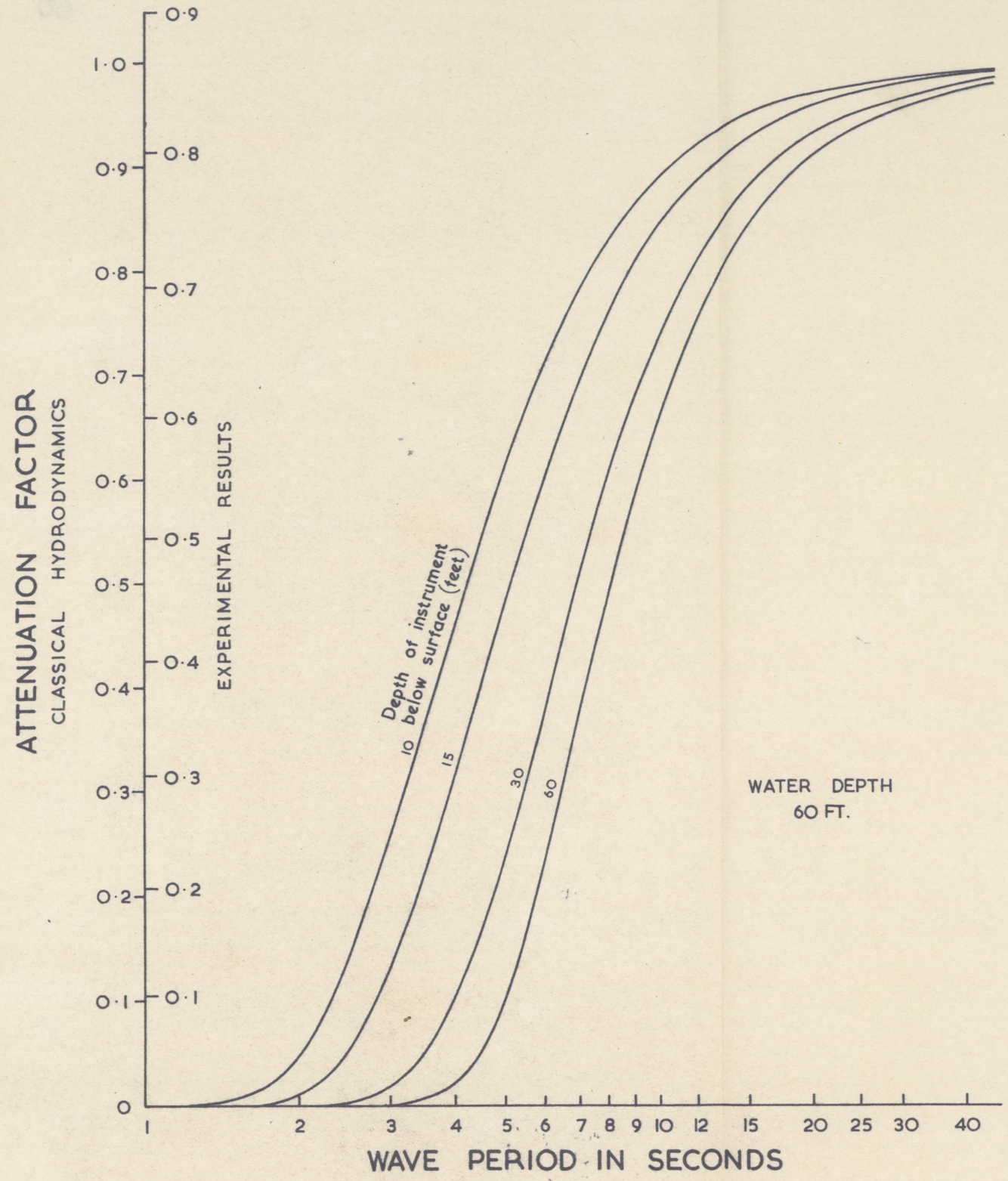

ATTENUATION FACTOR
CLASSICAL HYDRODYNAMICS
EXPERIMENTAL RESULTS
0·9
1·0
0·8
0·9
0·7
0·8
0·6
0·7
0·5
0·6
0·4
0·5
0·3
0·4
0·2
0·3
0·1
0·2
0·1
0
Depth of instrument below surface (feet)
10
15
20
35
WATER DEPTH
35FT.
1
2
3
4
5
6
7
8
9
10
12
15
20
25
30
40
WAVE PERIOD IN SECONDS


ATTENUATION FACTOR
CLASSICAL HYDRODYNAMICS
EXPERIMENTAL RESULTS
0·9
1·0
0·8
0·9
0·7
0·8
0·6
0·7
0·5
0·6
0·4
0·5
0·3
0·4
0·2
0·3
0·1
0·2
0
0·1
Depth of instrument below surface (feet)
10
15
25
40
WATER DEPTH
40 FT.
1
2
3
4
5
6
7
8
9
10
12
15
20
25
30
40
WAVE PERIOD IN SECONDS


ATTENUATION FACTOR
CLASSICAL HYDRODYNAMICS
EXPERIMENTAL RESULTS
0·9
1·0
0·8
0·9
0·7
0·8
0·6
0·7
0·5
0·6
0·4
0·5
0·3
0·4
0·2
0·3
0·1
0·2
0
0·1
Depth of instrument below surface (feet)
10
15
35
50
WATER DEPTH 50 FT.
1
2
3
4
5
6
7
8
9
10
15
20
25
30
40
WAVE PERIOD IN SECONDS



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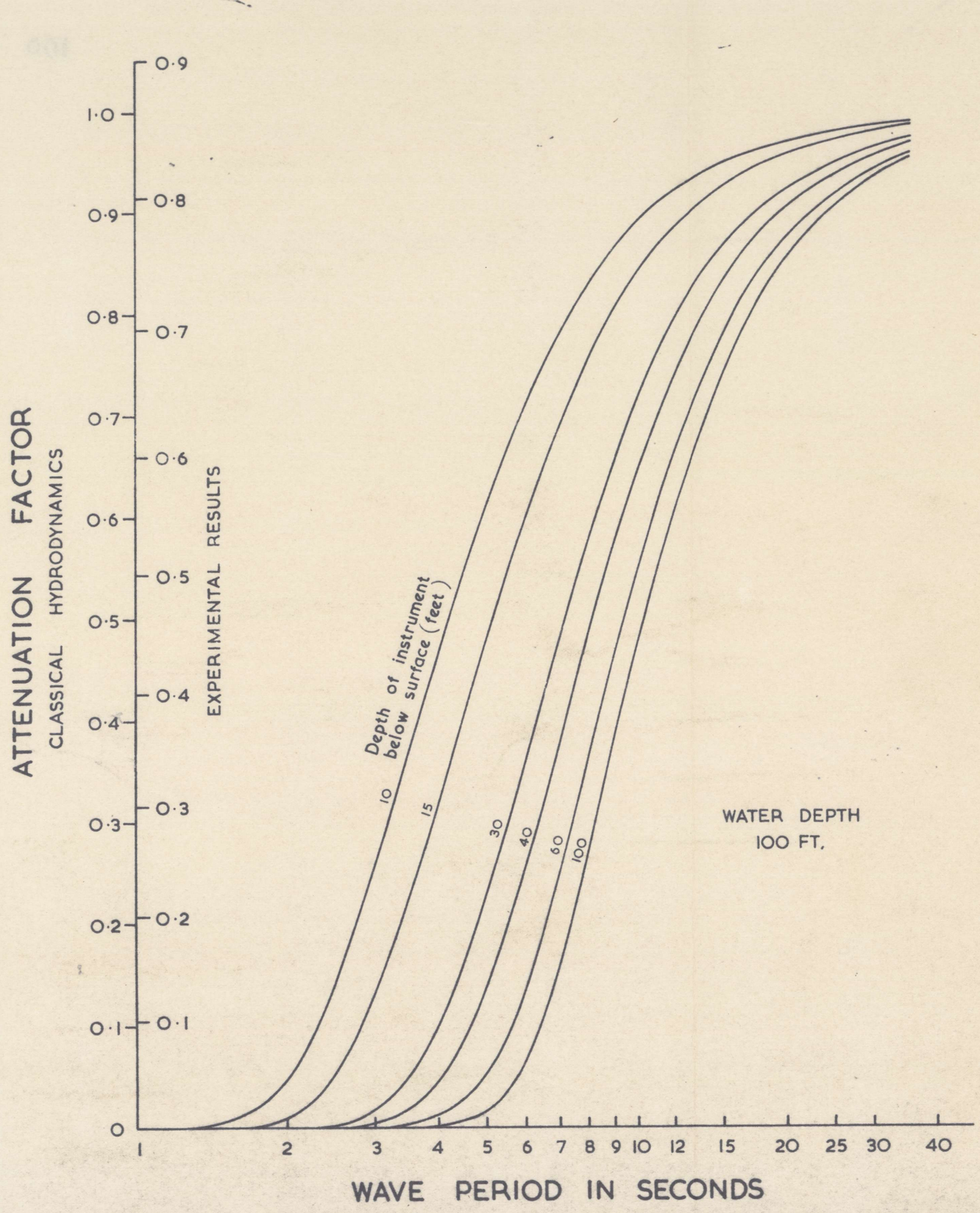

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