#### NRL Report 4433

### DESIGN AND CALIBRATION OF MICCOVIAVE ANTENNA GAIN STANDARDS

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William T. Slayton

Microwave Antennas and Components Branch Electronics Division

November 9, 1954



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#### ABSTRACT

A set of antenna gain-standard horns covering the microwave range from 0.77 cm to 31.5 cm has been designed and carefully calibrated. The horn fabrication is simple and can be duplicated accurately from the drawings supplied. A simple method of extending and improving the accuracy of Schelkunoff's gain curves is also described.

#### PROBLEM STATUS

This is a final report on this phase of the problem; work on the problem is continuing.

#### AUTHORIZATION

NRL Problem R09-03 Project NR 689-030

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#### DESIGN AND CALIBRATION OF MICROWAVE ANTENNA GAIN STANDARDS

#### INTRODUCTION

The need for accurate and practical microwave antenna gain standards has led to the design and calibration of a series of pyramidal horns covering the microwave bands from 0.77 cm to 31.5 cm. The series consists of eleven broadband horns having gains ranging from 24.7 db to 13.7 db. There is a horn for each waveguide size in the range. The horns can be easily and accurately duplicated from drawings supplied in this report.

#### DESIGN

Three requirements were considered of prime importance in the design: a useful gain figure, simplicity of construction, and accuracy of calibration. The fabricated type of horn (Fig. 1), with flat metal sheets forming the sides, was decided upon as the best means of satisfying the construction requirements. For simplicity, the horns were

designed so that the E- and H-plane flares meet the waveguide is a common plane.

Another consideration was the over-all size and weight. It was impractical to scale the horns from one band to another throughout the range, since the horns at the longer wavelengths would be too large and those at the shorter wavelengths too small. Accordingly, there are five different designs; each of the other six horns was' scaled from one of these.

The 8-mm and 1.8-cm horns were scaled from the 1.25-cm horn; the 4.75-cm horn from the 3.2-cm horn; the 3.95-cm and 6-cm horns from the 10-cm horn; and the 15-cm horn from the 23-cm horn. In scaling, the values of  $L_{\rm H}$  had to be altered slightly in order to make a simple junction at the waveguide. This was necessary because, with one or two exceptions, the inside dimensions of the waveguides are not scaled from one band to another. The adjustment made only a very slight change in the calculated gain (about 0.02 to 0.03 db).



Fig. 1 - Physical dimensions for calculating the gain

The 3.95-cm horn represents an overlapping of the 3.2-cm band and the 4.75-cm band. However, it was decided to include this horn in the series because it fits a standard waveguide size  $(1.250 \times 0.625 \text{ in}, \text{O.D.})$  and it provided an opportunity 'o make experimental checks on the 10-cm horn from which it is scaled.

The basic design data including the dimensions, operating range, and design-point gain for all the horns are summarized in Table A-2.\*

Readers who are interested in a detailed design procedure are referred to the Appendix, where a simple means of extending the range of Schelkunoff's gain curves and improving the accuracy of the gain figure obtainable from them is described. This method eliminates the necessity for long computations involving Fresnel integrals, and yields very close agreement with the detailed calculations.

#### CONSTRUCTION

As mentioned previously, the fabricated type of horn using flat metal sidets was decided upon as most suitable. The one exception is the 8-mm design, where electroforming was considered necessary because of the small size and close tolerances. Horns for the hands from 1.25 cm to 10 cm were made of brass sheets. At the 15-, 23-, and 30-cm bands, horns were fabricated from sheet aluminum using helium gas to facilitate welding the joints (heliarc process). This construction reduced the weight considerably and was found to be satisfactory for producing accurate, uniform, and rugged horns.

Dimensions for each set of horns are given in Figs. A-6 through A-17.

#### CALIBRATION

Experimental primary gain measurements (Fig. 2) were made in order to check the accuracy of the calculated gain.<sup>†</sup> Great care was taken in making these measurements. Both the horns and the bolometer detectors were carefully matched and the bolometer amplifier and output taeter (VTVM) were calibrated accurately. The bolometer amplifier was found to be linear throughout the range used. The use of r-f coaxial cables was avolded because of instability, waveguide being used instead. Microwave absorbent material (1) was used to minimize reflections. Even so, difficulties were encountered at the longer wavelengths because of reflections and the large separation distances required. As Braun has shown (2), true Fraunholer field conditions do not exist until a separation distance between horns of many times  $2d^2/\lambda$  is attained, d being the larger aperture dimension. Because of these difficulties, experimental gain measurements at 10 cm and above were abandoned. It was decided to scale the 3.95-cm and 6-cm horns from the 10-cm horn in order to obtain reliable measurements at the shorter wavelengths. Figure 3 shows the anechoic test site. An example of the method used in ovaluating the experimental data is given in the Appendix.



Fig. 2 - Experimental setup for gain measurements

<sup>&</sup>lt;sup>4</sup>With the exception of Fig. A-1, all figures and tables bearing the letter A are grouped at the end of the Appendix, and are listed on page 6.

<sup>&</sup>lt;sup>†</sup>For a general description of the methods used in making such measurements see Footno<sup>+</sup>r<sup>2</sup>, p. 7 of the Appendix, ref. pp. 582-585. The remarks in this reference about the minimum separation distance for the horns should be re-evaluated in the light of Ref. 2.



Fig. 3 - Anechoic test site

Measurements were made at several separation distances in each case, and were repeated many times, changing such variables as the power level and the peaking of the horns. See Figs. 3 and 4.



Gain curves for each band are shown in Fig. A-5 (2, b, c). Figures A-4 (2-1) show the field patterns for three basic horn designs.

#### REMARKS

Horns representing four basic designs were measured for mismatch over their bands. The greatest VSWR's encountered in the various bands are as follows:

Band	Max VSWR
1.8 cm	1.10
3.2 cm	1.20
6 cm	1.25
23 cm	1.20

The horns for the other bands should have a VSWR close to that of the horns from which they were scaled.

In any event, when the horns are used in gain measurements, the VSWR should be measured at the wavelength used, and for accurate measurements the horns should be carefully matched, or allowance should be made for any trismatch. In either case the bolometer must be well-matched. The use of flange-to-flange connections rather than chokes, is recommended whenever operating at a wavelength differing from that for which the chokes were designed, since at some wavelengthe choke-to-flange joints may introduce considerable mismatch.

#### ACCURACY

At any one wavelength the measured points showed a dispersion of less than 0.1 db. As a function of wavelength, the gain curve is not monotonic, as would be predicted from the theory, but shows small, though definite, periodic wiggles (see Fig. A-5 (b)). After exhaustive checking it is felt that these wiggles are actually present, and not due to experimental difficulties. This effect can probably be attributed to higher modes in the aperture and currents on the outside of the horn, both of which are neglected in the theory. However, since the wiggles are small, and since a tremendous amount of additional data would have to be taken to reproduce the wiggles accurately, a curve drawn through the average of the measured points was used. Taking into account all possible deviations from the true gain over each band, it was decided that the maximum possible error would be less than  $\pm 0.3$  db up to and including  $2^{-1}$  10-cm horns.

At wavelengths longer than 10 cm, where no direct experimental checks have been feasible, the gain has been calculated by means of Schelkunoff's formula. To arrive at a reasonable tolerance at these wavelengths, it was note that below 10 cm the greatest discrepancy between the average measured gain (using Braun's correction curves<sup>2</sup> for near field effects) and the calculated gain at the same wavelength was of the order of 0.2 db. In general the difference was much less than this figure. Therefore it is felt that a tolorance of  $\pm 0.5$  db is reasonable for all horns above the 10-cm band. In all probability, the actual errors are considerably less than the maximum possible tolerances quoted.

#### ACKNOWLEDGMENTS

The author wishes to express his appreciation to E. H. Braun for his advice and cooperation and to F. W. Lashway for his suggestions in connection with the construction of the horns.

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#### REFERENCES

- 1. Simmons, A. J., and Emerson, W. H., "An Anechoic Chamber Making Use of a New Broadband Absorbing Material," NRL Report 4193, 7 July 1953
- 2. Braun, E. H., "Gain of Electromagnetic Horns," Proc. I.R.E., Vol. 41, No. 1, pp. 109-115, Jan. 1953

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#### APPENDIX Methods for Determining Horn Dimensions and Gain

#### BACKGROUND

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Schelkunoif's gain curves in various forms<sup>1,2,3</sup> were used for determining the tentative dimensions of the horns and for obtaining a first approximation to the gain. After the aperture dimensions had been chosen and a reasonable value for  $L_E$  (the E-plane slant height) had been set, the H-plane slant height,  $L_H$ , was uniquely determined by the requirement that the flared sides of the horn meet the waveguide in the same plane (Fig. 1, p. 1). For the purpose of calculating the expected gain, this value of  $L_H$  was approximated by the relation

$$\beta_{H_{approx.}} = \frac{1 - \frac{\pi}{b}}{1 - \frac{\pi}{a}} \beta_{L}$$
(1)

where **s** = H-plane aperture dimension

b = E-plane aperture dimension

 $w_{r}$  = E-plane laside dimension of the waveguide

 $w_{\mu}$  = H-plane inside dimension of the waveguide.

After the tentative gain had been determined, the exact value of  $L_{\rm H}$  was obtained from the formula

$$k_{\rm H} = \frac{a}{1-v_{\rm H}} \sqrt{\left[\left(L_{\rm E}\right)^2 - \left(\frac{\rm b}{2}\right)^2\right] \left[\left(1-\frac{v_{\rm H}}{\rm b}\right)^2\right] + \left[\frac{a-v_{\rm H}}{2}\right]^2} \,. \tag{2}$$

#### <sup>1</sup>Schelkunoff, S. A., "Electromagnetic Waves," D. Van Nostrand, Inc., New York, pp. 363-365, 1943

<sup>2</sup>Silver, S., "Microwave Antenna Theory & Design," McGraw-Hill Book Co., Inc., New York, pp. 535-589, 1949

<sup>3</sup>Schelkunoff, S. A., and Frils, H. T., "Antennas - Theory and Practice," John Wiley and Sons, Inc., New York, pp. 528-529, 1952 In using Scheikunoff's gain curves, it was found that no one family of curves in the references mentioned covered a range great enough to include all the desired sizes of horns. Furthermore, certain parts of the curves were found to be less accurate than others. To overcome these difficulties a new procedure has been devised.<sup>4</sup> A brief review of the relationship of the curves to the gain formula will help to clarify the procedure. The notation is substantially that used in the recent book by Schelkunoff and Frits, <sup>3</sup> and by Silver.<sup>2</sup>

The Schelkunoff curves give the directive gain for horns flared in either of the two principal planes;  $g_g$  is the directive gain of a sectoral horn flared in the E-plane, and  $g_H$ is the directive gain of a sectoral horn flared in the H-plane. The two sectoral gain curves are obtained from the following formulas, expressed in terms of the tabulated Fresnel integrals C(X) and S(X):

$$\frac{\lambda}{b}g_{H} = \frac{4\pi k_{H}}{a} \left[ \left\{ C(u) - C(v) \right\}^{2} + \left\{ S(u) - S(v) \right\}^{2} \right]$$
(3)

$$\frac{\lambda}{a} x_{\Sigma} = \frac{54L_{\Sigma}}{\pi b} \left[ C^2(w) + S^2(w) \right], \qquad (4)$$

$$u = \frac{1}{\sqrt{2}} \left( \frac{\sqrt{\lambda} \overline{L_{H}}}{a} + \frac{a}{\sqrt{\lambda} \overline{L_{H}}} \right)$$
$$v = \frac{1}{\sqrt{2}} \left( \frac{\sqrt{\lambda} \overline{L_{H}}}{a} - \frac{a}{\sqrt{\lambda} \overline{L_{H}}} \right)$$
$$z = \frac{b}{\sqrt{2} \lambda \overline{L_{T}}}$$

 $\lambda =$  wavelength.

The gain of a pyramidal horn is

$$g = \frac{8\pi \ell_{E} \ell_{H}}{ab} \left[ C^{2}(w) + r^{2}(w) \right] \left[ \left\{ C(u) - C(v) \right\}^{2} + \left\{ S(u) - S(v) \right\}^{2} \right]$$

This result can easily be obtained from the two sectoral curves by multiplying together  $(\lambda/a)g_{\mu}$  and  $(\lambda/b)g_{H}$ , and dividing the result by  $32/\pi = 10.1859$ , yielding the convenient formula

$$\mathbf{g} = \frac{\begin{pmatrix} \lambda \\ \mu \end{pmatrix} \mathbf{g}_{\mathrm{E}}}{\frac{32}{\pi}} \begin{pmatrix} \lambda \\ h \end{pmatrix} \mathbf{g}_{\mathrm{E}}$$
(5)

where  $\frac{\lambda}{a} g_{E}$  and  $\frac{\lambda}{b} g_{II}$  are read directly from the curves.

<sup>4</sup>Braun, E. H. "Calculation of the Gain of Small Horns," Proc. I.R.E., Vol. 41, No. 12, pp. 1785-6, Dec. 1953

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where

#### EXTENSION AND APPLICATION

Braun's method<sup>4</sup> provides a convenient means of extending the range of the gain curves and eliminating the inaccuracy arising from interpolations between curves. He introduces the arbitrary factors  $k_g$  and  $k_H$  to create a fictitious horn having these dimensions:

$$\mathbf{e} = \mathbf{k}_{H} \mathbf{A}, \quad \mathbf{b}_{H} = \mathbf{k}_{H}^{2} \mathbf{L}_{H}$$
$$\mathbf{b} = \mathbf{k}_{E} \mathbf{B}, \quad \mathbf{b}_{E} = \mathbf{k}_{E}^{2} \mathbf{L}_{E}$$

where A, B,  $L_E$ , and  $L_H$  are the actual horn dimensions. By choosing the proper value for  $k_E$  and  $k_H$ , one can make  $L_E$  and  $L_H$  fall exactly on one of the respective gain curves for each plane. After the gain of the fictilious hern ( $\pi_{fict}$ ) is read from the curves, the gain of the actual horn ( $\pi_{act}$ ) is obtained from the relation

$$g_{uct.} = \frac{g_{lict.}}{k_z k_H}$$

Since both  $k_{z}$  and  $k_{H}$  are arbitrary, one gain curve for each plane is all that is necessary. The Schelkunoff curves for  $L_{z} = 50\lambda$  and  $L_{H} = 50\lambda$  are convenient for this purpose and have been accurately recomputed and plotted on an expanded scale in Figs. A-2 (a,b) and A-3 (a,b) so that they may be read with such accuracy that it is no longer necessary to make the detailed calculations involved in using the gain formula. The curves were plotted from formulas (3) and (4). The values obtained from these formulas are tabulated in Table A-1. For maximum accuracy these values may be preferable to those obtained from the curves. Linear interpolation between points will yield good accuracy. The table makes it possible to plot any desired portions of the curves on whatever scale is preferred.

An example will demonstrate the simplicity of the method.

Actual horn:  $A = 8.13\lambda$ ,  $L_{H} = 19.72\lambda$  $B = 6.67\lambda$ ,  $L_{g} = 18.52\lambda$ 

If it is desired to make use of the 50- $\lambda$  curves referred to above, the k's are chosen as follows:

$$k_{E}^{2} = \frac{50\lambda}{18.52\lambda} = 2.6998, k_{E} = 1.643,$$
  
 $k_{H}^{2} = \frac{50\lambda}{19.72\lambda} = 2.5355, k_{H} = 1.592.$ 

Fictitious horn:  $b = k_{g} = B = 10.96\lambda$ ,  $L_{g} = 50\lambda$ ,

$$a = k_{H} A = 12.94\lambda, L_{H} = 50\lambda.$$

From the 50-A gain curves

 $\frac{\lambda}{n} q_R = 80.77$  $\frac{\lambda}{h} r_H = 98.92 \cdot 1000$ 

From formula (5),

Rfict. = 
$$\frac{\left(\frac{\lambda}{a}R_{\rm g}\right)\left(\frac{\lambda}{b}K_{\rm H}\right)}{\frac{32}{\pi}}$$
 = 784.40

$$R_{act.} = \frac{R_{fict.}}{k_{g}} = 299.88$$
, or 24.77 db.

Detailed calculations using the Fresnel integrals in the gain formula resulted in the same gain figure, 24.77 db. Similar comparisons at each of the other bands showed agreement within 0.01 db.

#### USE OF CORRECTION CURVES

The procedure for determining the true Fraunhofer gain from the primary gain test data, using Braun's near field correction curves, Fig. A-1 (a,b), is shown in the following example taken from actual measurements:

X-band horn dimensions: s = 7.654 in.,  $l_{\tilde{n}} = 13.484$  in.

 $b = 5.669 \text{ in.}, \ l_{\pi} = 12.598 \text{ in.}$ 

 $\lambda = 3.20$  cm = 1.2598 in.

R [distance between horns] = 140.25 in.

$$\frac{4\pi R}{\lambda} = \frac{(12.566)(140.25)}{1.2593} = 1398.9.$$

From test data  $\frac{P_T}{P_R} = \frac{11.3}{0.123} = 91.87; \qquad \sqrt{\frac{P_T}{P_R}} = 9.585$ 

where  $P_{T}$  represents power transmitted and  $P_{R}$  power received.

Gain<sub>uncorrected</sub> = 
$$\frac{\frac{4\pi R}{\lambda}}{|\vec{P}_R|} = \frac{1398.9}{9.585} = 145.95$$
, or 21.64 db.

Parameters for using the correction curves:

E-plane:

$$\frac{8l_{E}}{b^{2}} = \frac{(8)(12,598)}{32.13} = 3.1360$$

$$E = \left(\frac{9l_{Z}}{b^{2}}\right) \quad \lambda \approx (3.1360)(1.2598) = 3.951$$

$$\log \frac{\lambda R}{12} = \log \frac{(1.2598)(140,25)}{32.13} = \log 5.498 = 0.740$$



(a) E-plane



(b) H-plane



H-plane:

$$\frac{3L_{\rm H}}{a^2} = \frac{(3)(13,484)}{58,584} = 1.8413$$

$$H = \left(\frac{3L_{H}}{a^{2}}\right) \lambda = (1.8413)(1.2598) = 2.320$$

$$\log \frac{\lambda R}{a^{2}} = \log \frac{(1.2598)(140.25)}{58.584} = \log 3.016 = 0.479$$

Reading from the correction curves:

Corrected gain		22.14 db
Uncorrected gain (above)		21.64 db
Total correction	********	0.50 db
H-plane correction	*****	0.28 db
E-plane correction		0.22 db

The calculated gain, using Schelkunoff's formula, in this case was the same: 22.14 db.

#### DETERMINATION OF AN OPTIMUM HORN WITH SPECIFIED GAIN AND EQUAL BEAMWIDTHS

A simple means has been devised for finding the dimensions of a horn which satisfies the following requirements:

- (1) Specified gain
- (2) Cottimum horn\*
- (3) Equal beamwidths at the half-power points.

Although this can be done empirically, z act of factors was determined .rom Schelkunoff's gain formula, which yield the required horn parameters as a function of the absolute gain, g, alone.<sup>†</sup> These are as follows:

<sup>T</sup>This has been worked out by E. H. Braun in an unpublished report.

<sup>\*</sup>An optimum horn is one for which the aperture dimensions have been chosen to give maximum gain when the slant heights are held fixed. This is the case when  $a^2 \cong 3.18\lambda I_{\rm H}$  and  $b^2 \cong 2.08\lambda I_{\rm H}$ 

```
\frac{a}{\lambda} = 0.4675 yr

\frac{b}{\lambda} = 0.3463 yr

\frac{l_T}{\lambda} = 0.05764 r

\frac{l_T}{\lambda} = 0.06885 r
```

where  $\bullet$ , b,  $l_{r}$ , and  $l_{H}$  are the usual parameters as defined (p.7).

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A horn having these dimensions will have exactly the desired theoretical gain, and will be exactly an optimum horn. However, it should be pointed out that where a simple joint between the flared horn and the waveguide is desired, the value of  $L_R$  must be modified to make the horn fit the guide. This will change the gain by a small amount, usually a few tenths of a db, since the horn will no longer be exactly optimum. If a discrepancy of this magnitude in not important,  $L_R$  can be calculated to fit the waveguide exactly, using formula (2).

When a closer approach to the specified gain is desired, a slight change in the procedure is necessary. This is accomplished by the following steps:

- (1) Compute tentative parameters a', b', and  $L_{z'}$  in the same way as a, b, and  $L_{z}$  were computed above.
- (2) Obtain the approximate value,  $L_{\rm H}'$ , to fit the waveguide, using formula (1), p. 7.
- (3) Calculate the tentative gain, g', by the method outlined on p. 9 using the primed parameters.
- (4) Recompute s, b, and  $L_z$ , substituting  $g^2/g^2$  for g
- (5) Obtain the exact value of  $L_{\rm H}$  from formula (2)
- (6) Recalculate the gain for the new parameters.

Since the theoretical gain is obtained very accurately in step 6, it is easy to determine the discrepancy between the desired gain and that now resulting from the adjustment to fit the waveguide.



Fig. A-2 (a). Expanded E-plane theoretical gain curve

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Fig. A-2 (b). Expanded E-plane theoretical gain curve



Fig. A-3 (a). Expanded H-plane theoretical gain curve



Fig. A-3 (b). Expanded H-plane theoretical gain curve

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#### TABLE A-1 Data for Theoretical Gain Curves

L	(a) E-Plane ( $l_E = 50\lambda$ )												
ь	$\frac{\lambda}{a} \mathbf{F}_{\mathbf{Z}}$	Ь	λ se	ь		Ь	y K <sup>E</sup>	Ь	2 8g	ь	λ ε <sub>ε</sub>	Ь	À BE
2.0	20.362	4.6	46.397	7.2	69.123	9.8	81.301	12.4	73.784	15.0	46.493	17.6	19.910
2.1	21.381	4.7	47.362	2 7.3	69.847	9.9	81.426	12.5	73.041	15.1	45.268	17.7	19.316
2.2	22.395	4.8	40 291		71.333	10.0	81.581	12.0	71 459	115.2	44.040	17.0	18 264
2.4	24.425	5.0	50.233	7.6	71.923	10.2	81.611	12.8	70.621	15.4	41.593	18.0	17.805
2.5	25.440	5.1	51.181	7.7	72.586	10.3	81.609	12.9	69.753	15.5	40.379	18.1	17.395
2.6	26.456	5.2	52.123	7.8	73.219	10.4	81.575	13.0	68.556	15.6	39.174	18.2	17.030
2.7	27.472	5.3	53.057	7.9	73-841	10.5	81.510	113.1	67.931	115.7	37.982	18.3	16.714
2.8	28.481	5.4	153.985	8.0	74.441	10.0	1408	13.2	66 001	15.8	30.801	10.4	10.445
2.9	30 503	13.3	55 821	18.2	75.585	10.8	81.110	13.4	64.997	16.0	34.488	18.6	16.048
3.1	31.511	5.7	56.72	9.3	76.127	10.9	80.000	13.5	63.969	15.1	33.359	19.7	15.921
3.2	32.518	S.R	\$7.620	18.4	76.645	11.0	80.676	13.6	62.917	16.2	32.250	18.8	15.839
3.3	33.527	5.9	58.517	8.5	77.142	11.1	80.405	13.7	61.844	16.3	31.164	18.9	15.804
3.4	34.530	6.0	59.401	8.6	77.616	11.2	80.104	13.8	60.748	16.4	30,104	19.0	15.814
3.5	35.531	0.1	60.272	13./	78.000	11.3	70 101	13.9	57.635	10.5	29.009	19.1	15.070
3.0	30.334	6.2	61 087	8.9	78.892	11.5	78.987	14.1	57.351	16.7	27.086	19.3	16.108
3.8	38.530	6.4	62.828	9.0	79.269	11.6	78.545	14.2	56.188	16.8	26.142	19.4	16.289
3.9	39.524	6.5	63.659	9.1	79.619	111.7	78.068	14.3	55.008	16.9	25.232	19.5	16.521
4.0	40.515	6.6	64.477	9.2	79.944	11.8	77.559	14.4	53.816	17.0	24.355	19.6	16.769
4.1	41.504	6.7	65.285	19.3	80.240	11.9	77.014	14.5	52.614	17.1	23.515	19.7	17.064
4.2	42.490	0.8	100.UNJ	9.4	80.510	12.0	10.435	14.0	51.402	17.2	22.713	19.8	17.394
4.3	44.450	7.0	67.630	9.5	80.964	12.2	75 176	114.8	18.959	17.4	21.931	20.0	18.147
4.5	45.425	7.1	68.385	9.7	81.146	12.3	74.497	14.9	47.731	17.5	20.548	1	
			-										
					(b)	H-PI	ene (L <sub>H</sub>	= 50)	· · · · · · · · · · · · · · · · · · ·	لمحرب لي			
•	<u>Ъ</u> в <sub>и</sub>	•	A RH	•	(b) <u> }</u> <u> k</u>	H-PI	ine (L <sub>H</sub> $\frac{\lambda}{b}$ L <sub>H</sub>	= 50\) •	A BH	•			<u>À</u> е <sub>н</sub>
• 2.0	<u>ћ</u> е <sub>н</sub> 20.370	4.6	<u>Ъ</u> г <sub>н</sub> 46.635	•	(b) <u> <u> </u> </u>	H-P1	the $(l_{\rm H})$ $\frac{\lambda}{b} r_{\rm H}$ 90.533	= 50) • 12.4	<u>ћ</u> в <sub>и</sub> 99.019	•	λ ε <sub>R</sub> 92.591	17.6	<u>À</u> е <sub>н</sub> 75.416
• 2.0 2.1	<u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u></u>	* 4.6 4.7	<u>λ</u> <u>b</u> 46.635 47.628	• 7.2 7.3	(b) <u> <u> </u> </u>	H-P11	ene (L <sub>H</sub> <u>A</u> E <sub>H</sub> 90.533 91.195	= 50)	<u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u></u>	15.0 15.1	λ ε <sub>R</sub> 92.591 92.066	<b>1</b> 7.6 17.7	<u>ћ</u> е <sub>н</sub> 75.416 74.701
<b>a</b> 2.0 2.1 2.2	<u>λ</u> <sub>B</sub> 20.370 21.387 22.402	<b>4.6</b> <b>4.7</b> <b>4.8</b>	λ b <b>F</b> <sub>H</sub> 46.635 47.628 48.619 49.600	<b>1</b> 7.2 7.3 7.4	(b) <u> <u> </u> </u>	H-P1	ne (L <sub>H</sub> <u>A</u> E <sub>H</sub> 90.533 91.195 91.740 92.270	= 50) 12.4 12.5 12.6 12.7	<u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u></u>	15.0 15.1 15.2	$\frac{\lambda}{b}$ <b>E</b> <sub>R</sub> 92.591 92.066 91.523 60.972	<b>a</b> 17.6 17.7 17.8	<u>À</u> Е <sub>Н</sub> 75.416 74.701 73.991 73.282
2.0 2.1 2.2 2.3 2.4	<u>λ</u> <sub>B</sub> 20.370 21.387 22.402 23.422 24.439	<b>a</b> 4.6 4.7 4.8 4.9 5.0	<u>λ</u> g <sub>H</sub> 46.635 47.628 48.619 49.609 50.595	<b>7.2</b> 7.3 7.4 7.5 7.6	(b) <u> <u> </u> </u>	H-P11 9.8 9.9 10.0 10.1 10.2	ane $(L_{\rm H})$ b $R_{\rm H}$ 90.533 91.195 91.740 92.270 92.781	= 50λ) 12.4 12.5 12.6 12.7 12.3	<u>λ</u> <b>g</b> <sub>H</sub> 99.019 99.052 99.052 99.052 99.051 99.012	15.0 15.1 15.2 15.3 15.4	<u>λ</u> <b>g</b> <sub>R</sub> 92.591 92.066 91.523 90.972 90.400	17.6 17.7 17.8 17.9 13.0	<u>À</u> Е <sub>Н</sub> 75.416 74.701 73.991 73.282 72.581
• 2.0 2.1 2.2 2.3 2.4 2.5	<u>λ</u> ε <sub>н</sub> 20.370 21.387 22.402 23.422 24.439 25.452	4.6 4.7 4.8 4.9 5.0 5.1	λ g <sub>H</sub> 46.635 47.628 48.619 49.609 50.595 51.578	• 7.2 7.3 7.4 7.5 7.6 7.7	(b) <u> <u> </u> 71.291 72.164 73.031 73.889 74.739 75.580</u>	H-P11 9.8 9.9 10.0 10.1 10.2 10.3	ane (L <sub>H</sub> <u>b</u> L <sub>H</sub> 90.533 91.195 91.740 92.270 92.781 93.274	= 50) 12.4 12.5 12.6 12.7 12.3 12.9	<u>λ</u> <b>g</b> <sub>H</sub> 99.019 99.052 99.062 99.051 99.012 98.053	15.0 15.1 15.2 15.3 15.4 15.5	<u>λ</u> <b>ξ</b> <sub><b>h</b></sub> 92.591 92.066 91.525 90.972 90.400 89.822	17.6 17.7 17.8 17.9 13.0 18.1	<u>À</u> <b>Е</b> н 75.416 74.701 73.991 73.282 72.581 71.886
2.0 2.1 2.2 2.3 2.4 2.5 2.6	<u>λ</u> E <sub>N</sub> 20.370 21.387 22.402 23.422 24.439 25.452 26.471	4.6 4.7 4.8 4.9 5.0 5.1 5.2	<u>λ</u> <b>F</b> <sub>H</sub> 46.635 47.628 48.619 49.609 50.595 51.578 52.559	<b>a</b> 7.2 7.3 7.4 7.5 7.6 7.7 7.8	(b) <u> <u> </u> </u>	H-P1 9.8 9.9 10.0 10.1 10.2 10.3 10.4	ene (L <sub>H</sub> <u>b</u> E <sub>H</sub> 90.533 91.195 91.740 92.270 92.781 93.274 93.751	= 50) 12.4 12.5 12.6 12.7 12.3 12.9 13.0	<u>λ</u> ε <sub>μ</sub> 99.019 99.052 99.062 99.051 99.012 98.253 98.871	15.0 15.1 15.2 15.3 15.4 15.5 15.6	<u>λ</u> <b>E</b> <sub>B</sub> 92.591 92.066 91.523 90.972 50.400 89.822 89.214	17.6 17.7 17.8 17.9 13.0 18.1 18.2	<u>À</u> <b>Е</b> н 75.416 74.701 73.991 73.282 72.581 71.886 71.199
2.0 2.1 2.2 2.3 2.4 2.5 2.6 2.7	λ ε <sub>N</sub> 20.370 21.387 22.402 23.422 24.439 25.452 26.471 27.488	4.6 4.7 4.8 4.9 5.0 5.1 5.2 5.3	<u>λ</u> <b>F</b> <sub>H</sub> 46.635 47.628 48.619 49.609 50.595 51.578 52.559 53.536	<b>1</b> 7.2 7.3 7.4 7.5 7.6 7.7 7.8 7.9	(b) <u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u></u>	H-Pi 9.8 9.9 10.0 10.1 10.2 10.3 10.4 10.5	ene ( $\mathcal{L}_{\rm H}$ b $\mathcal{L}_{\rm H}$ 90.533 91.195 91.740 92.270 92.781 93.274 93.751 94.208	= 50) 12.4 12.5 12.6 12.7 12.3 12.9 13.0 13.1	<u>λ</u> <b>E</b> <sub>H</sub> 99.019 99.052 99.062 99.051 99.012 98.053 98.871 98.763	15.0 15.1 15.2 15.3 15.4 15.5 15.6 15.7	<u>λ</u> <b>g</b> <sub>R</sub> 92.591 92.066 91.523 90.972 50.400 89.822 89.214 88.601	17.6 17.7 17.8 17.9 13.0 18.1 18.2 18.3	<u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u></u>
2.0 2.1 2.2 2.3 2.4 2.5 2.6 2.7 2.8	λ ε <sub>H</sub> 20.370 21.387 22.402 23.422 24.439 25.452 26.471 27.488 28.501	4.6 4.7 4.8 4.9 5.0 5.1 5.2 5.3 5.4 5.5	<u>λ</u> <b>r</b> <sub>H</sub> 46.635 47.628 48.619 49.609 50.595 51.578 52.559 53.536 54.512	<b>1</b> 7.2 7.3 7.4 7.5 7.6 7.7 7.8 7.9 8.0	(b) <u><u></u><u>b</u> <u></u><u>b</u> 71.291 72.164 73.031 73.889 74.739 75.580 76.413 77.236 78.049 76.611</u>	H-Pis 9.8 9.9 10.0 10.1 10.2 10.3 10.4 10.5 10.6	ene (L <sub>H</sub> <u>b</u> E <sub>H</sub> 90.533 91.195 91.740 92.270 92.781 93.274 93.751 94.208 94.646 55.657	= 50) 12.4 12.5 12.6 12.7 12.3 12.9 13.0 13.1 13.2 13.2	<u>λ</u> <b>g</b> <sub>H</sub> 99.019 99.052 99.062 99.051 99.012 98.953 98.871 98.763 98.638 98.638	15.0 15.1 15.2 15.3 15.4 15.5 15.6 15.7 15.8 15.7	<u>λ</u> <b>g</b> <sub>R</sub> 92.591 92.066 91.523 90.972 90.972 90.400 89.822 89.214 88.601 87.976 87.27	2 17.6 17.7 17.8 17.9 13.0 18.1 18.2 18.3 18.4	<u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u></u>
<b>a</b> 2.0 2.1 2.2 2.3 2.4 2.5 2.6 2.7 2.8 2.9	<u>λ</u> <b>E</b> <sub>H</sub> 20.370 21.387 22.402 23.422 24.439 25.452 26.471 27.488 28.501 29.518 20.522	4.6 4.7 4.8 4.9 5.0 5.1 5.2 5.3 5.4 5.5 5.4 5.5	<u>λ</u> <u>b</u> <u>b</u> <u>46.635</u> 47.628 48.619 49.609 50.595 51.578 52.559 53.536 54.512 55.4450 56.4450	<b>a</b> 7.2 7.3 7.4 7.5 7.6 7.7 7.8 7.9 8.0 8.1 8.1	(b) <u> <u> </u> 71.291 72.164 73.031 73.889 74.739 75.580 76.413 77.236 78.049 75.854 78.049 75.854 79.644</u>	H-P11 9.8 9.9 10.0 10.1 10.2 10.3 10.4 10.5 10.6 10.7	ene (L <sub>H</sub> <u>b</u> E <sub>H</sub> 90.533 91.195 91.740 92.270 92.781 93.274 93.751 94.646 95.067 65.470	= 50) 12.4 12.5 12.6 12.7 12.3 12.9 13.0 13.1 13.2 13.3	<u>λ</u> ε <sub>H</sub> 99.019 99.052 99.062 99.051 99.012 98.053 98.871 98.763 98.638 93.466 98.466 98.400	15.0 15.1 15.2 15.3 15.4 15.5 15.6 15.7 15.8 15.9 16.0	<u>λ</u> <b>g</b> <sub>R</sub> 92.591 92.066 91.523 90.972 90.972 90.400 89.822 89.214 88.601 87.976 87.337 86.688	2 17.6 17.7 17.8 17.9 13.0 18.1 18.2 18.3 18.4 18.5 18.6	<u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u></u>
2.0 2.1 2.2 2.3 2.4 2.5 2.6 2.7 2.8 2.9 3.0	<u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u></u>	<b>a</b> 4.6 4.7 4.8 4.9 5.0 5.1 5.2 5.3 5.4 5.5 5.6 5.7	<u>λ</u> <u>b</u> <u>b</u> <u>c</u> <u>c</u> <u>c</u> <u>c</u> <u>c</u> <u>c</u> <u>c</u> <u>c</u>	<b>a</b> 7.2 7.3 7.4 7.5 7.6 7.7 7.8 7.9 8.0 8.1 8.2 8.3	(b) <u> <u> </u> 71.291 72.164 73.031 73.889 74.739 75.580 76.413 77.236 78.049 73.854 79.644 80.427</u>	H-P11 9.8 9.9 10.0 10.1 10.2 10.3 10.4 10.5 10.6 10.7 10.8	ene (L <sub>H</sub> <u>b</u> L <sub>H</sub> 90.533 91.195 91.740 92.270 92.781 93.274 93.274 93.751 94.646 95.067 95.848	= 50) 12.4 12.5 12.6 12.7 12.3 12.9 13.0 13.1 13.2 13.3 13.4 13.5	<u>λ</u> ε <sub>H</sub> 99.019 99.052 99.052 99.051 99.012 98.253 98.871 98.763 98.638 98.638 98.638 98.436 98.309 98.114	<b>15.0</b> <b>15.1</b> <b>15.2</b> <b>15.3</b> <b>15.4</b> <b>15.5</b> <b>15.6</b> <b>15.7</b> <b>15.8</b> <b>15.9</b> <b>16.0</b> <b>16.1</b>	λ         ε           b         8           92.591         92.056           91.523         90.972           92.400         89.822           89.214         88.601           87.976         87.337           86.638         86.026	17.6 17.7 17.8 17.9 13.0 18.1 18.2 18.3 18.4 18.5 18.6 18.7	<u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u></u>
2.0 2.1 2.2 2.3 2.4 2.5 2.6 2.7 2.8 2.9 3.0 3.1 3.2	<u>λ</u> E <sub>H</sub> 20.370 21.387 22.402 23.422 24.439 25.452 26.471 27.488 28.501 29.518 30.532 31.545 32.560	<b>a</b> 4.6 4.7 4.8 4.9 5.0 5.1 5.2 5.3 5.4 5.5 5.5 5.6 5.7 5.8	<u>λ</u> g <sub>H</sub> <u>b</u> H 46.635 47.628 48.619 49.609 50.595 51.578 52.559 53.536 54.512 55.475 56.449 57.418 53.377	<b>1</b> 7.2 7.3 7.4 7.5 7.6 7.7 7.8 7.9 8.0 8.1 8.1 8.2 8.3 8.4	(b) $\frac{\lambda}{b} \frac{k}{r_{H}}$ 71.291 72.164 73.031 73.889 74.739 75.580 76.413 77.236 78.049 75.854 79.644 80.427 31.196	H-P11 9.8 9.9 10.0 10.1 10.2 10.3 10.4 10.5 10.6 10.7 10.8 10.9 11.0	ene ( $\mathcal{L}_{H}$ <u>b</u> $\mathcal{L}_{H}$ 90.533 91.195 91.740 92.270 92.781 93.274 93.751 94.208 94.646 95.067 95.848 96.207	= 50) 12.4 12.5 12.6 12.7 12.3 12.9 13.0 13.1 13.2 13.3 13.4 13.5 13.6	λ         ε           b         8           99.019         99.052           99.052         99.051           99.051         98.753           98.763         98.763           98.638         93.466           98.309         93.114           97.894         93.454	<b>15.0</b> <b>15.1</b> <b>15.2</b> <b>15.3</b> <b>15.4</b> <b>15.5</b> <b>15.6</b> <b>15.7</b> <b>15.8</b> <b>15.9</b> <b>16.0</b> <b>16.1</b> <b>16.2</b>	λ         ε           92.591         92.056           91.523         90.972           92.4400         89.214           88.601         87.976           87.337         86.688           86.026         85.355	17.6 17.7 17.8 17.9 13.0 18.1 18.2 18.3 18.4 18.5 18.6 18.7 18.8	<u>À</u> е <sub>н</sub> 75.416 74.701 73.991 73.282 72.581 71.886 71.199 70.516 69.847 69.183 68.534 67.891 67.262
2.0 2.1 2.2 2.3 2.4 2.5 2.6 2.7 2.8 2.9 3.0 3.1 3.2 3.3	$\frac{\lambda}{b} \mathbf{g}_{H}$ 20.370 21.387 22.402 23.422 24.439 25.452 26.471 27.488 28.501 29.518 30.532 31.545 32.560 33.573	4.6 4.7 4.8 4.9 5.0 5.1 5.2 5.3 5.4 5.5 5.6 5.7 5.8 5.9	<u>λ</u> g <sub>H</sub> 46.635 47.628 48.619 49.609 50.595 51.578 52.559 53.536 54.512 55.475 56.449 57.418 53.377 59.334	<b>1</b> 7.2 7.3 7.4 7.5 7.6 7.7 7.8 8.0 8.1 8.2 8.3 8.4 8.3 8.4 8.5	(b) $\frac{\lambda}{b} \frac{\kappa}{r_{H}}$ 71.291 72.164 73.031 73.889 74.739 75.580 76.413 77.236 76.413 77.236 78.049 75.854 79.644 80.427 81.956	H-P11 9.8 9.9 10.0 10.1 10.2 10.3 10.4 10.5 10.6 10.7 10.8 10.9 11.0 11.1	ene ( $\mathcal{L}_{H}$ <u>b</u> $\mathcal{L}_{H}$ 90.533 91.195 91.740 92.270 92.781 93.274 93.751 94.208 94.646 95.067 95.848 96.207 96.547	= 50) 12.4 12.5 12.6 12.7 12.3 12.9 13.0 13.1 13.2 13.3 13.4 13.5 13.6 13.7	λ         g           b         %           99.019         99.052           99.062         99.051           99.051         98.71           98.763         98.638           98.456         98.309           98.114         97.894           97.654         94	<b>15.0</b> <b>15.1</b> <b>15.2</b> <b>15.3</b> <b>15.4</b> <b>15.5</b> <b>15.6</b> <b>15.7</b> <b>15.8</b> <b>15.9</b> <b>16.0</b> <b>16.1</b> <b>16.2</b> <b>16.3</b>	λ         ε           92.591         92.056           91.523         90.972           92.460         89.822           89.214         88.601           87.976         87.337           86.638         86.026           85.355         64.677	17.6 17.7 17.8 17.9 13.0 18.1 18.2 18.3 18.4 18.5 18.6 18.5 18.6 18.7 18.8 18.9	<u>À</u> е <sub>н</sub> 75.416 74.701 73.991 73.282 72.581 71.886 71.199 70.516 69.847 69.183 68.534 67.891 67.262 56.643
2.0 2.1 2.2 2.3 2.4 2.5 2.6 2.7 2.8 2.9 3.0 3.1 3.2 3.3 3.4	$\frac{\lambda}{b} \mathbf{g}_{H}$ 20.370 21.387 22.402 23.422 24.439 25.452 26.471 27.488 28.501 29.518 30.532 31.545 32.560 33.573 34.579	4.6 4.7 4.8 4.9 5.0 5.1 5.2 5.3 5.4 5.5 5.5 5.6 5.7 5.8 5.9 6.0	<u>λ</u> g <sub>H</sub> 46.635 47.628 48.619 49.609 50.595 51.578 52.559 53.536 54.512 55.475 56.449 57.418 53.377 59.334 60.265	<b>1</b> 7.2 7.3 7.4 7.5 7.6 7.7 7.8 8.0 8.1 8.2 8.3 8.4 8.5 8.6	(b) $\frac{\lambda}{b} \frac{\mu}{r_H}$ 71.291 72.164 73.031 73.889 74.739 75.580 76.413 77.236 78.049 75.854 79.644 80.427 81.956 81.956 82.703	H-P11 9.8 9.9 10.0 10.1 10.2 10.3 10.4 10.5 10.6 10.7 10.8 10.9 11.0 11.1 11.2	ene ( $\mathcal{L}_{H}$ <u>b</u> $\mathcal{L}_{H}$ 90.633 91.195 91.740 92.270 92.781 93.274 93.751 94.208 94.646 95.067 95.848 96.207 96.547 96.869	= 50) 12.4 12.5 12.6 12.7 12.3 12.9 13.0 13.1 13.2 13.3 13.4 13.5 13.6 13.7 13.8	λ         g <sub>H</sub> b         g <sub>H</sub> 99.019         99.052           99.062         99.051           99.051         98.012           98.753         98.871           98.638         98.638           98.456         98.309           98.114         97.894           97.654         97.387	<b>15.0</b> <b>15.1</b> <b>15.2</b> <b>15.3</b> <b>15.4</b> <b>15.5</b> <b>15.6</b> <b>15.7</b> <b>15.8</b> <b>15.9</b> <b>16.0</b> <b>16.1</b> <b>16.2</b> <b>16.3</b> <b>16.3</b> <b>16.4</b>	λ         ε           92.591         92.056           91.523         90.972           92.400         89.822           89.214         88.601           87.976         87.337           86.638         86.026           85.355         64.677           83.990         990	17.6 17.7 17.8 17.9 13.0 18.1 18.2 18.3 18.4 18.5 18.6 18.7 18.8 18.9 19.0	<u>À</u> е <sub>н</sub> 75.416 74.701 73.991 73.282 72.581 71.886 71.199 70.516 69.847 69.183 68.534 67.891 67.262 56.643 66.038
2.0 2.1 2.2 2.3 2.4 2.5 2.6 2.7 2.8 2.9 3.0 3.1 3.2 3.3 3.4 3.5	$\frac{\lambda}{b} \mathbf{g}_{H}$ 20.370 21.387 22.402 23.422 24.439 25.452 26.471 27.488 28.501 29.518 30.532 31.545 32.560 33.573 34.579 35.595	4.6 4.7 4.8 4.9 5.0 5.1 5.2 5.3 5.4 5.5 5.5 5.6 5.7 5.8 5.9 6.0 6.1	$\begin{array}{c} \underline{\lambda} \\ \underline{b} \\ \underline{b} \\ \underline{c} \\ $	<b>7.2</b> <b>7.3</b> <b>7.4</b> <b>7.5</b> <b>7.6</b> <b>7.7</b> <b>7.8</b> <b>7.7</b> <b>7.8</b> <b>8.0</b> <b>8.1</b> <b>8.2</b> <b>8.3</b> <b>8.4</b> <b>8.5</b> <b>8.6</b> <b>5.7</b>	(b) $\frac{\lambda}{b} \mathbf{g}_{H}$ 71.291 72.164 73.031 73.889 74.739 75.580 76.413 77.236 78.049 75.854 79.644 80.427 81.956 82.703 83.440	H-P11 9.8 9.9 10.0 10.1 10.2 10.3 10.4 10.5 10.6 10.7 10.8 10.9 11.0 11.1 11.2 11.3	ene ( $\mathcal{L}_{H}$ <u>b</u> $\mathcal{L}_{H}$ 90.633 91.195 91.740 92.270 93.274 93.274 93.274 93.751 94.646 95.067 95.848 96.207 96.547 96.869 97.168	= 50) 12.4 12.5 12.6 12.7 12.3 12.9 13.0 13.1 13.2 13.3 13.4 13.5 13.6 13.7 13.8 13.9	<u>λ</u> <b>g</b> <sub>H</sub> 99.019 99.052 99.062 99.051 99.012 98.253 98.871 98.763 98.638 98.763 98.638 98.763 98.638 98.763 98.763 98.763 98.763 98.763 97.763 97.101 97.101	<b>15.0</b> <b>15.1</b> <b>15.2</b> <b>15.3</b> <b>15.4</b> <b>15.5</b> <b>15.6</b> <b>15.7</b> <b>15.8</b> <b>15.9</b> <b>16.0</b> <b>16.1</b> <b>16.2</b> <b>16.3</b> <b>16.4</b> <b>16.5</b>	<u>λ</u> <b>g</b> <sub>R</sub> 92.591 92.066 91.523 90.972 50.400 89.822 89.214 88.601 87.976 87.337 86.638 86.026 85.355 64.677 83.990 83.319	17.6 17.7 17.8 17.9 13.0 18.1 18.2 18.3 18.4 18.5 18.6 18.7 18.8 18.9 19.0 19.1	À ε <sub>H</sub> 5.416 74.701 73.991 73.282 72.581 71.886 71.199 70.516 69.847 69.183 68.534 67.891 67.262 56.643 66.038 65.447 64.87
2.0 2.1 2.2 2.3 2.4 2.5 2.6 2.7 2.8 3.0 3.1 3.2 3.3 3.4 3.5 3.6	<u>λ</u> <b>B</b> <sub>H</sub> 20.370 21.387 22.402 23.422 24.439 25.452 26.471 27.488 28.501 29.518 30.532 31.545 32.560 33.573 34.579 35.595 36.605	4.6 4.7 4.8 4.9 5.0 5.1 5.2 5.3 5.4 5.5 5.5 5.7 5.8 5.9 6.0 6.1 6.2	$\begin{array}{c} \lambda \\ \mathbf{g}_{H} \\ \mathbf{h} \\ \mathbf$	7.2 7.3 7.4 7.5 7.7 7.8 7.9 8.0 8.1 8.2 8.3 8.4 8.5 8.6 5.7 8.8 6 5.7 8.8	(b) $\frac{\lambda}{b} g_{H}$ 71.291 72.164 73.031 73.889 74.739 75.580 76.413 77.236 78.049 75.854 79.644 80.427 81.956 82.703 83.440 84.164 94.976	H-P11 9.8 9.9 10.0 10.1 10.2 10.3 10.4 10.5 10.6 10.7 10.8 10.9 11.0 11.1 11.2 11.3 11.4	ene ( $\mathcal{L}_{H}$ $\frac{\lambda}{b}$ $\mathcal{E}_{H}$ 90.633 91.195 91.740 92.270 93.274 93.274 93.274 93.274 93.274 94.646 95.067 95.848 96.207 96.547 96.547 96.869 97.168 97.168 97.202	= 50) 12.4 12.4 12.5 12.6 12.7 12.3 12.9 13.0 13.1 13.2 13.3 13.4 13.5 13.6 13.7 13.8 13.9 14.0	<u>λ</u> g <sub>H</sub> 99.019 99.052 99.062 99.051 99.012 98.753 98.871 98.763 98.638 98.638 98.486 98.309 98.114 97.894 97.387 97.101 95.793 96.64	<b>15.0</b> <b>15.1</b> <b>15.2</b> <b>15.3</b> <b>15.4</b> <b>15.5</b> <b>15.6</b> <b>15.7</b> <b>15.8</b> <b>15.7</b> <b>15.8</b> <b>15.9</b> <b>16.0</b> <b>16.1</b> <b>16.2</b> <b>16.3</b> <b>16.4</b> <b>16.5</b> <b>16.6</b> <b>16.5</b>	<u>λ</u> <b>g</b> <sub>R</sub> 92.591 92.066 91.523 90.972 50.400 89.822 89.214 88.601 87.976 87.337 86.638 86.026 85.355 64.677 83.990 83.319 82.594 81.839	17.6 17.7 17.8 17.9 13.0 18.1 18.2 18.3 18.4 18.5 18.6 18.7 18.8 18.9 19.0 19.1 19.2	<u>À</u> е <sub>н</sub> 75.416 74.701 73.991 73.282 72.581 71.886 71.199 70.516 69.847 69.183 68.534 67.891 67.262 56.643 65.038 65.038 65.447 64.871 64.871 64.05
2.0 2.1 2.2 2.3 2.4 2.5 2.6 2.7 2.8 3.0 3.1 3.2 3.3 3.4 3.5 3.6 3.7	<u>λ</u> <b>B</b> <sub>H</sub> 20.370 21.387 22.402 23.422 24.439 25.452 26.471 27.488 28.501 29.518 30.532 31.545 32.560 33.573 34.579 35.595 35.605 37.612	4.6 4.7 4.8 4.9 5.0 5.1 5.2 5.3 5.4 5.5 5.5 5.7 5.8 5.9 6.0 3.1 6.2 6.3	$\begin{array}{c} \lambda \\ \mathbf{g}_{H} \\ \mathbf{h} \\ \mathbf$	7.2 7.3 7.4 7.5 7.7 7.8 7.9 8.0 8.1 8.2 8.3 8.4 8.5 8.6 6.7 8.8 8.9 9.9	(b) $\frac{\lambda}{b} \frac{\mu}{r_H}$ 71.291 72.164 73.031 73.889 74.739 75.580 76.413 77.236 78.049 75.854 79.644 80.427 81.956 82.703 83.440 84.164 84.875 85.567	H-P11 9.8 9.9 10.0 10.1 10.2 10.3 10.4 10.5 10.6 10.7 10.8 10.9 11.0 11.1 11.2 11.3 11.4 11.5 11.6	ene ( $\mathcal{L}_{H}$ <u>h</u> $\mathcal{L}_{H}$ 90.633 91.195 91.740 92.270 93.274 93.274 93.274 93.274 94.646 95.067 95.848 96.207 96.547 96.547 96.547 96.547 96.547 97.168 97.168 97.702 97.038	= 50) 12.4 12.4 12.5 12.6 12.7 12.3 12.9 13.0 13.1 13.2 13.3 13.4 13.5 13.6 13.7 13.8 13.9 14.0 14.0 14.2	<u>λ</u> g <sub>M</sub> 99.019 99.052 99.062 99.051 99.012 98.753 98.871 98.763 98.763 98.638 98.763 98.763 98.763 98.763 98.763 98.763 98.763 98.763 98.763 97.894 97.894 97.894 97.387 97.101 95.793 96.464 96.113	<b>15.0</b> <b>15.1</b> <b>15.2</b> <b>15.3</b> <b>15.4</b> <b>15.5</b> <b>15.6</b> <b>15.7</b> <b>15.8</b> <b>15.9</b> <b>16.0</b> <b>16.1</b> <b>16.2</b> <b>16.3</b> <b>16.4</b> <b>16.5</b> <b>16.6</b> <b>16.6</b> <b>16.7</b> <b>16.8</b>	<u>λ</u> <b>g</b> <sub>R</sub> 92.591 92.066 91.523 90.972 53.400 89.822 89.214 88.601 87.976 87.337 86.638 86.026 85.355 64.677 83.990 83.319 82.594 81.838 81.179	17.6 17.7 17.8 17.9 13.0 18.1 18.2 18.3 18.4 18.5 18.6 18.7 18.8 18.9 19.0 19.1 19.2 19.3 19.4	À E <sub>H</sub> 5.416 74.701 73.991 73.282 72.581 71.886 71.199 70.516 69.847 69.183 68.534 67.262 56.643 65.038 65.447 64.871 64.305 64.305 64.3758
<b>2.0</b> <b>2.1</b> <b>2.2</b> <b>2.3</b> <b>2.4</b> <b>2.5</b> <b>2.6</b> <b>2.7</b> <b>2.8</b> <b>3.1</b> <b>3.3</b> <b>3.4</b> <b>3.5</b> <b>3.6</b> <b>3.7</b> <b>3.6</b> <b>3.7</b> <b>3.6</b> <b>3.7</b> <b>3.6</b> <b>3.7</b> <b>3.6</b> <b>3.7</b> <b>3.6</b> <b>3.7</b> <b>3.6</b> <b>3.7</b> <b>3.6</b> <b>3.7</b> <b>3.6</b> <b>3.7</b> <b>3.6</b> <b>3.7</b> <b>3.6</b> <b>3.7</b> <b>3.6</b> <b>3.7</b> <b>3.6</b> <b>3.7</b> <b>3.6</b> <b>3.7</b> <b>3.6</b> <b>3.7</b> <b>3.6</b> <b>3.7</b> <b>3.6</b> <b>3.7</b> <b>3.6</b> <b>3.7</b> <b>3.6</b> <b>3.7</b> <b>3.6</b> <b>3.7</b> <b>3.6</b> <b>3.7</b> <b>3.6</b> <b>3.7</b> <b>3.6</b> <b>3.7</b> <b>3.6</b> <b>3.7</b> <b>3.6</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>5.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.7</b> <b>3.73.7</b> <b>3.7</b> <b>3.73.7</b> <b>3.73.7</b> <b>3.7</b> <b>3.7</b> <b>3.73.7</b> <b>3.73.7</b> <b>3.7</b> <b>3.71111111111111</b>	<u>λ</u> <b>B</b> <sub>H</sub> 20.370 21.387 22.402 23.422 24.439 25.452 26.471 27.488 28.501 29.518 30.532 31.545 32.560 33.573 34.579 35.595 35.605 37.612 38.622 39.629	<b>4.6</b> <b>4.7</b> <b>4.8</b> <b>4.9</b> <b>5.1</b> <b>5.2</b> <b>5.3</b> <b>5.4</b> <b>5.5</b> <b>5.5</b> <b>5.7</b> <b>5.8</b> <b>5.7</b> <b>5.8</b> <b>5.0</b> <b>5.1</b> <b>5.5</b> <b>5.7</b> <b>5.8</b> <b>5.0</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.7</b> <b>5.8</b> <b>5.0</b> <b>5.1</b> <b>5.2</b> <b>5.3</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> 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99.051 99.012 98.763 98.871 98.763 98.638 98.309 98.114 97.894 97.894 97.387 97.101 95.793 96.464 96.113 95.740	15.0 15.1 15.2 15.3 15.4 15.5 15.6 15.7 15.8 15.9 16.0 16.1 16.2 16.3 16.4 16.5 16.6 16.5 16.6 16.5 16.8 16.9	À <b>E</b> <sub>R</sub> 92.591 92.066 91.523 90.972 90.972 90.972 89.822 89.214 88.601 87.976 87.337 86.638 86.026 85.355 64.677 83.990 83.319 83.319 82.594 81.838 81.179 €0.461	17.6 17.7 17.8 17.9 13.0 18.1 18.2 18.3 18.4 18.5 18.6 18.7 18.8 18.9 19.0 19.1 19.2 19.3 19.4 19.5	<u>Ъ</u> Ен 5.416 74.701 73.991 73.282 72.581 71.886 71.199 70.516 69.847 69.183 68.534 67.891 67.262 56.643 65.447 64.871 64.871 64.305 63.758 63.222
2.0 2.1 2.2 2.3 2.4 2.5 2.6 2.7 2.8 2.9 3.1 3.3 3.4 3.5 3.6 3.7 3.3 3.4 3.5 3.6 3.7 3.8 9 4.0	λ         B <sub>H</sub> 20.370           21.387           22.402           23.422           24.439           25.452           26.471           27.488           28.501           29.518           30.532           31.545           32.560           33.573           34.579           35.595           37.612           38.622           39.629           40.633	<b>4.6</b> <b>4.7</b> <b>4.8</b> <b>4.9</b> <b>5.1</b> <b>5.2</b> <b>5.3</b> <b>5.4</b> <b>5.5</b> <b>5.7</b> <b>5.8</b> <b>5.7</b> <b>5.8</b> <b>5.7</b> <b>5.8</b> <b>5.0</b> <b>5.1</b> <b>5.5</b> <b>5.7</b> <b>5.8</b> <b>5.0</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.2</b> <b>5.3</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.6</b> <b>5.1</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.1</b> <b>5.6</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.65.6</b> <b>5.655.6</b> <b>5.65555555555555</b>	$\begin{array}{c} \lambda \\ \mathbf{g}_{H} \\ \mathbf{h} \\ \mathbf$	7.2 7.3 7.4 7.5 7.7 7.8 7.9 8.0 8.1 8.2 8.3 8.4 8.5 8.4 8.5 8.6 6.7 8.8 8.9 9.0 9.1 9.2	(b) $\frac{\lambda}{b} \frac{\kappa}{r_{H}}$ $\frac{\gamma}{1.291}$ 72.164 73.031 73.889 74.739 75.580 76.413 77.236 78.049 75.854 79.644 80.427 81.196 81.956 82.703 83.440 84.164 84.875 85.567 85.567 86.250 86.923	H-PI 9.8 9.9 10.0 10.1 10.2 10.3 10.4 10.5 10.6 10.7 10.8 10.9 11.0 11.1 11.2 11.3 11.4 11.5 11.6 11.7 11.8	ne (L <sub>H</sub> <u>b</u> L <sub>H</sub> 90.533 91.195 91.740 92.270 92.781 93.274 93.751 94.208 94.646 95.067 95.848 96.207 96.869 97.168 97.445 97.702 97.938 98.149 98.342	= 50) 12.4 12.4 12.5 12.6 12.7 12.3 12.9 13.0 13.1 13.2 13.3 13.4 13.5 13.6 13.7 13.8 13.6 13.7 13.8 13.9 14.0 14.1 14.2 14.3 14.4	<u>λ</u> <b>g</b> <sub>H</sub> 99.019 99.052 99.052 99.051 99.012 98.763 98.763 98.638 98.763 98.638 98.309 98.114 97.894 97.101 97.101 95.793 96.464 96.113 95.740 95.348	15.0           15.1           15.2           15.3           15.4           15.5           15.6           15.7           15.8           15.9           16.0           16.1           16.2           16.3           16.4           16.5           16.6           16.7           16.8           16.9           17.0	λ         ε           b         8           92.591         92.056           91.523         90.972           90.400         89.822           89.822         89.214           88.601         87.976           87.337         86.638           86.026         85.355           64.677         83.990           83.319         82.594           81.853         81.179           80.461         79.742	17.6 17.7 17.8 17.9 13.0 18.1 18.2 18.3 18.4 18.5 18.6 18.7 18.8 18.9 19.0 19.1 19.2 19.3 19.4 19.5 19.6	<u>Ъ</u> Ен 75.416 74.701 73.991 73.282 72.581 71.886 71.199 70.516 69.847 69.183 68.534 67.891 67.262 56.643 66.038 65.447 64.871 64.305 63.758 63.222 62.703
2.0 2.1 2.2 2.3 2.4 2.5 2.6 2.7 2.8 2.9 3.1 3.2 3.4 3.5 3.4 3.5 3.5 3.6 7 3.8 9 4.1	$\frac{\lambda}{b} g_{H}$ 20.370 21.387 22.402 23.422 24.439 25.452 26.471 27.488 28.501 29.518 30.532 31.545 32.560 33.573 34.579 35.595 35.505 37.612 38.622 39.629 40.633 41.637	<b>4.6</b> <b>4.7</b> <b>4.8</b> <b>5.1</b> <b>5.2</b> <b>5.3</b> <b>5.4</b> <b>5.5</b> <b>5.7</b> <b>5.8</b> <b>5.7</b> <b>5.8</b> <b>5.7</b> <b>5.8</b> <b>5.7</b> <b>5.8</b> <b>5.7</b> <b>5.8</b> <b>5.0</b> <b>5.1</b> <b>5.5</b> <b>5.7</b> <b>5.8</b> <b>5.0</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.1</b> <b>5.5</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.7</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.6</b> <b>5.65.7</b> <b>5.6</b> <b>5.65.75.6</b> <b>5.655.755.655.655.655.655.655.775.655.655.775.655.655.6555.7755.65555555555555</b>	$\begin{array}{c c} \lambda & \mathbf{g}_{H} \\ \mathbf{b} & \mathbf{f}_{H} \\ 46.635 \\ 47.628 \\ 48.619 \\ 49.609 \\ 50.595 \\ 51.578 \\ 52.559 \\ 53.536 \\ 54.512 \\ 55.475 \\ 56.449 \\ 57.418 \\ 57.418 \\ 57.314 \\ 59.334 \\ 69.265 \\ 61.232 \\ 52.176 \\ 63.115 \\ 64.045 \\ 64.975 \\ 65.896 \\ 66.810 \end{array}$	<b>a</b> <b>7.2</b> <b>7.3</b> <b>7.4</b> <b>7.5</b> <b>7.6</b> <b>7.7</b> <b>7.8</b> <b>7.9</b> <b>8.0</b> <b>8.1</b> <b>8.2</b> <b>8.3</b> <b>8.4</b> <b>8.5</b> <b>8.6</b> <b>5.7</b> <b>8.8</b> <b>8.5</b> <b>8.5</b> <b>8.5</b> <b>8.5</b> <b>8.9</b> <b>9.0</b> <b>9.1</b> <b>9.2</b> <b>9.3</b>	(b) $\frac{\lambda}{b} \frac{\kappa}{r_{H}}$ 71.291 72.164 73.031 73.889 74.739 75.580 76.413 77.236 78.049 75.644 80.427 81.956 81.956 82.703 83.440 84.164 84.875 85.567 26.250 85.923 27.579	H-PI 9.8 9.9 10.0 10.1 10.2 10.3 10.4 10.5 10.6 10.7 10.8 10.9 11.0 11.1 11.2 11.3 11.4 11.5 11.6 11.7 11.8 11.9	ne (L <sub>H</sub> <u>b</u> L <sub>H</sub> 90.533 91.195 91.740 92.270 92.781 93.274 93.751 94.208 94.646 95.067 95.848 96.547 96.869 97.168 97.168 97.445 97.702 97.938 98.149 98.342 98.510	= 50) 12.4 12.5 12.6 12.7 12.3 12.9 13.0 13.1 13.2 13.3 13.4 13.5 13.6 13.7 13.8 13.9 14.0 14.1 14.2 14.3 14.4 14.5 15 15 15 15 15 15 15 15 15 1	λ         ε <sub>H</sub> 99.019         99.052           99.052         99.052           99.051         99.051           99.053         98.871           98.763         98.763           98.763         98.456           98.309         98.114           97.387         97.101           95.793         96.464           96.113         95.740           95.348         94.936	15.0           15.1           15.2           15.3           15.4           15.5           15.6           15.7           15.8           15.9           16.0           16.1           16.2           16.3           16.4           16.5           16.6           16.7           16.8           16.9           17.0           7.1	λ         ε           92.591         92.056           91.523         90.972           93.400         89.822           89.214         88.601           87.976         87.337           86.638         86.026           85.355         64.677           83.990         83.319           82.594         81.853           81.179         80.461           79.742         79.023	17.6 17.7 17.8 17.9 13.0 18.1 18.2 18.3 18.4 18.5 18.6 18.7 18.8 18.9 19.0 19.1 19.2 19.3 19.4 19.5 19.6 19.7	<u>Ъ</u> <b>Е</b> н 75.416 74.701 73.991 73.282 72.581 71.886 71.199 70.516 69.847 69.183 68.534 67.891 67.262 56.643 65.447 64.871 64.305 63.758 63.222 62.703 52.201
2.0 2.1 2.2 2.3 2.4 2.5 2.6 2.7 2.8 2.9 3.0 3.1 3.2 3.3 3.4 3.5 3.5 3.5 3.5 3.5 3.5 3.5 3.5 3.5 3.5	$\frac{\lambda}{b} g_{H}$ 20.370 21.387 22.402 23.422 24.439 25.452 26.471 27.488 28.501 29.518 30.532 31.545 32.560 33.573 34.579 35.595 35.605 37.612 38.622 39.629 40.633 41.637 42.645	4.6 4.7 4.8 4.9 5.0 5.1 5.2 5.3 5.4 5.5 5.5 5.5 5.5 5.7 5.8 5.0 5.1 5.2 5.7 5.5 5.5 5.7 5.8 5.0 5.1 5.2 5.5 5.5 5.5 5.5 5.5 5.5 5.5 5.5 5.5	$\begin{array}{c} \lambda \\ \mathbf{g}_{H} \\ \mathbf{b} \\ \mathbf{f}_{H} \\ \mathbf{f}_{6} \\ \mathbf{f}_{7} \\ \mathbf{f}_{2} \\ \mathbf{f}_{7} \\ \mathbf{f}_{2} \\ \mathbf{f}_{7} \\ \mathbf{f}$	<b>a</b> 7.2 7.3 7.4 7.5 7.6 7.7 7.8 7.9 8.0 8.1 8.2 8.3 8.4 8.5 8.6 6.7 8.8 8.6 6.7 8.8 8.9 9.0 9.1 9.2 9.1 9.2 9.3 9.4	(b) $\frac{\lambda}{b} \frac{\kappa}{r_{H}}$ 71.291 72.164 73.031 73.889 74.739 75.580 76.413 77.236 78.049 73.854 79.644 80.427 81.956 82.703 83.440 84.164 84.875 85.567 86.220 86.923 87.579 88.221	H-PI1 9.8 9.9 10.0 10.1 10.2 10.3 10.4 10.5 10.6 10.7 10.8 10.9 11.0 11.1 11.2 11.3 11.4 11.5 11.6 11.7 11.8 11.9 12.0	ne (L <sub>H</sub> <u>b</u> L <sub>H</sub> 90.533 91.195 91.740 92.270 92.781 93.274 93.751 94.208 94.646 95.067 95.848 96.207 96.547 96.547 96.547 96.547 96.547 96.547 97.168 97.168 97.168 97.168 97.168 97.202 98.149 98.342 98.342 98.3510 98.658	= 50λ) 12.4 12.5 12.6 12.7 12.3 12.9 13.0 13.1 13.2 13.3 13.4 13.5 13.6 13.7 13.8 13.9 14.0 14.1 14.2 14.3 14.4 14.5 14.6 14.5 14.6 14.5 14.6 14.5 14.6 14.5 14.6 14.5 14.6 14.5 14.6 14.5 14.6 15.6 15.7 15.8 15.7 15.8 15.7 15.8 15.7 15.8 15.7 15.8 15.7 15.8 15.7 15.8 15.7 15.8 15.7 15.8 15.7 15.8 15.7 15.8 15.7 15.8 15.7 15.8 15.7 15.8 15.7 15.8 15.7 15.8 15.	<u>λ</u> ε <sub>H</sub> 99.019 99.052 99.062 99.051 99.012 98.953 98.871 98.763 98.638 98.638 98.486 98.309 95.114 97.894 57.654 97.387 97.101 95.793 96.464 96.113 95.740 95.348 94.936 94.504	15.0           15.1           15.2           15.3           15.4           15.5           15.6           15.7           15.8           15.9           16.1           16.2           16.3           16.4           16.5           16.6           16.7           16.8           16.9           17.0           7.1	λ         ε           92.591         92.066           91.523         90.972           92.400         89.822           89.214         88.601           87.976         86.638           86.026         85.355           64.677         83.990           83.319         82.594           81.853         81.179           80.461         79.742           79.023         78.301	17.6 17.7 17.8 17.9 13.0 18.1 18.2 18.3 18.4 18.5 18.6 18.7 18.8 18.9 19.0 19.1 19.2 19.3 19.4 19.5 19.6 19.7 19.8	<u>Ъ</u> <b>Е</b> н 75.416 74.701 73.991 73.282 72.581 71.886 71.199 70.516 69.847 69.183 68.534 67.891 67.262 56.643 65.038 65.447 64.871 64.305 63.758 63.222 62.703 52.201 51.714
2.0 2.1 2.2 2.3 2.4 2.5 2.6 2.8 9 3.0 3.2 3.3 3.4 3.5 3.6 3.3 3.4 3.5 3.6 3.7 3.9 0 4.1 4.2 4.3	$\frac{\lambda}{b} g_{H}$ 20.370 21.387 22.402 23.422 24.439 25.452 26.471 27.488 28.501 29.518 30.532 31.545 32.560 33.573 34.579 35.595 36.605 37.612 38.622 39.629 40.633 41.637 42.645 43.639	<b>4.6</b> <b>4.7</b> <b>4.8</b> <b>4.9</b> <b>5.0</b> <b>5.1</b> <b>5.2</b> <b>5.3</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.55.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.5</b> <b>5.55.5</b> <b>5.5</b> <b>5.5</b> <b>5.55.5</b> <b>5.5</b> <b>5.55.5</b> <b>5.5</b> <b>5.55.5</b> <b>5.5</b> <b>5.55.5</b> <b>5.555.5</b> <b>5.555.555.55555555555555</b>	$\begin{array}{c c} \lambda & \mathbf{g}_{H} \\ \mathbf{b} & \mathbf{f}_{H} \\ 46.635 \\ 47.628 \\ 48.619 \\ 49.609 \\ 50.595 \\ 51.578 \\ 52.559 \\ 53.536 \\ 54.512 \\ 55.475 \\ 56.449 \\ 57.418 \\ 57.418 \\ 57.418 \\ 57.334 \\ 69.265 \\ 61.232 \\ 52.176 \\ 63.115 \\ 64.046 \\ 64.975 \\ 65.896 \\ 66.810 \\ 67.720 \\ 63.623 \\ 63.513 \\ 63.613 \\ $	<b>1</b> 7.2 7.3 7.4 7.5 7.6 7.7 7.8 7.9 8.0 8.1 8.3 8.4 8.5 8.4 8.5 8.6 6.7 8.8 8.9 9.0 9.1 9.2 9.1 9.2 9.3 9.4 9.5	(b) $\frac{\lambda}{b} \frac{\kappa}{r_{H}}$ 71.291 72.164 73.031 73.889 74.739 75.580 76.413 77.236 78.049 75.584 79.644 80.427 81.956 81.956 82.703 83.440 84.164 84.875 85.567 86.250 86.923 87.5 <sup>79</sup> 88.221 83.844 84.60	H-PI 9.8 9.9 10.0 10.1 10.2 10.3 10.4 10.5 10.6 10.7 10.8 10.9 11.0 11.1 11.2 11.3 11.4 11.5 11.6 11.7 11.8 11.9 12.0 12.1	ne (L <sub>H</sub> <u>b</u> L <sub>H</sub> 90.533 91.195 91.740 92.270 92.781 93.274 93.274 93.751 94.646 95.848 94.646 95.848 96.207 95.848 96.207 95.848 96.207 95.848 96.207 95.848 96.207 95.848 96.207 95.848 96.207 95.848 96.207 95.848 96.207 95.848 96.207 95.848 96.207 95.848 96.207 95.848 96.207 95.848 96.207 95.848 96.547 95.848 97.168 97.168 97.168 97.168 97.168 97.702 98.149 98.342 98.510 98.658 98.783 98.783	= 50) 12.4 12.5 12.6 12.7 12.3 12.9 13.0 13.1 13.2 13.3 13.4 13.5 13.6 13.7 13.8 13.9 14.0 14.1 14.2 14.3 14.4 14.5 14.6 14.7 14.6 14.7 14.6 14.7 14.6 14.7 14.6 14.7 14.6 14.7 14.6 14.7 14.6 14.7 14.6 14.7 14.8 14.6 14.7 14.8 14.6 14.7 15.8 15.6 15.7 15.8 15.6 15.7 15.8 15.6 15.7 15.8 15.6 15.7 15.8 15.6 15.7 15.8 15.8	<u>λ</u> ε <sub>H</sub> 99.019 99.052 99.062 99.051 99.012 98.253 98.871 98.638 98.638 98.638 98.638 98.456 98.309 98.114 97.894 97.101 95.793 96.464 96.113 95.740 95.348 94.936 94.504 94.054 13.555	<b>15.0</b> <b>15.1</b> <b>15.2</b> <b>15.3</b> <b>15.4</b> <b>15.5</b> <b>15.6</b> <b>15.7</b> <b>15.8</b> <b>15.9</b> <b>16.0</b> <b>16.1</b> <b>16.2</b> <b>16.3</b> <b>16.4</b> <b>16.5</b> <b>16.6</b> <b>16.5</b> <b>16.6</b> <b>16.7</b> <b>16.8</b> <b>16.9</b> <b>17.0</b> <b>7.1</b> <b>17.2</b> <b>17.3</b> <b>17.4</b>	<u>λ</u> <b>ε</b> <sub>R</sub> 92.591 92.066 91.523 90.972 90.972 89.822 89.214 88.601 87.976 87.337 86.688 86.026 85.355 84.677 83.990 83.319 82.594 81.838 81.179 80.461 79.742 79.023 78.301 77.578 76.551	17.6 17.7 17.8 17.9 13.0 18.1 18.2 18.3 18.4 18.5 18.6 18.7 18.8 18.9 19.0 19.1 19.2 19.3 19.4 19.5 19.6 19.7 19.8 19.9	<u>λ</u> E <sub>H</sub> 75.416 74.701 73.991 73.282 72.581 71.886 71.199 70.516 69.847 69.183 65.534 67.891 67.262 56.643 65.038 65.447 64.871 64.305 63.758 63.222 62.703 52.201 61.714 61.243 50.788

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متعاشيات الروا منطق بالاستعالي للأمما بالمناصر برعاد معاقبهم تريعه

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مغب الاستعاصيص للمتابين المنطوف هلاس

N. K. K. K.

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Fig. A-4- E- and H-plane field patterns

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Fig. A-4 E- and H-plane field patterns

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Band	Frequency Range					Di	mensio (in	ns ( •)	Design- Point Frequency		Gain at Design Point (db)	
(8 mm	0.77	-	1.13	cm	a	=	2.720	b =	2.231	0.85 c	m	24.7
0	26,550	-	38,960	Mc	<i>L</i> <sub>H</sub>	=	6.513	<i>L</i> <sub>E</sub> =	6.197	35,290 M	lc	27.1
	1.13	-	1.66	cm	а	=	4.000	b =	3.281	1.25 c	m	
<b>1</b> · 25 cm	18,070	-	26,550	Mc	l <sub>H</sub>	=	9.706	<i>l</i> <sub>E</sub> =	9.113	24,000 M	c	24.7
	1 66	_	2 42	~ _		_	5 094		4 009	1.07 -		
L 1.8 cm	12,400	_	18.070	Mc	l.	_	14 222	0 0	12 622	16 040 M	m	24.7
	12,100		10,070		≁н	-	14:555	″E⁻	13.033	10,040 M	C	
( 3.2 cm	2.42	-	3.70	cm	a	=	7.654	b =	5.669	3.20 c	m	22.1
	8100	-	12,400 !	Mc	l <sub>H</sub>	=	13.484	<b>l</b> _E=	12.598	9375 M	c	22.1
	3.60	-	5.20	cm	а	=	11.360	b =	8.415	4.75 c	m	
( 4.75 cm	5770	-	8330 1	Mc	l <sub>H</sub>	=	20.014	<b>L</b> <sub>E</sub> =	18.700	6315 M	c	22.1
	2 00		4 20	_			- 041	ь_	3 733	2.05 -		
<b>∂</b> 3.95 cm	5.00	-	10 000 1	Cill Mo	a 0	-	3.041	0 =	3.733	3.95 C	m	18.0
	0980	-	10,000 1	NC	ЪН	=	/ • 44 /	<i>L</i> <sub>E</sub> =	0.333	7595 M	c	
5.6.00	5.10	-	7.60 0	cm	а	=	8.507	b =	6.300	6.67 c	m	10 0
	3950	-	5880 N	Mc	l <sub>h</sub>	=	12.462	<i>l</i> <sub>E</sub> =	11.062	4500 M	c	10.0
	7.60	-	11.5	cm	a	=	12.760	b =	9.450	10.00 c	m	
<b>(1</b> 0 cm	2600	-	3950 N	VIC	L <sub>u</sub>	=	18.682	L =	16.593	3000 M	c	18.0
	11 5		17 6				14 500	1				
(15 cm	11.5	~	17.0 0	Cm	a ⊿	Ξ	14.508	D =	10.747	15.22 C	m	15.5
1	1700	-	2000 1	NC	~н	Ξ	10.508	<i>L</i> <sub>E</sub> =	14.107	1970 M	C	
23 cm	17.6	-	26.5 d	cm	а	=	21.931	b =	16.245	23.00 c	m	15 5
	1130	-	1700 N	Mc	ľ,	=	24.955	$\boldsymbol{\ell}_{\mathbf{E}}$ =	21.325	1300 M	c	12.2
	26.0	-	31.5	cm	а	=	21.931	ь-	16.245	30.00 c	_	
30 cm	950	_	1150 M	Mc	<i>L</i> <sub>11</sub>	=	28.730	<i>l</i> <sub>F</sub> =	24.000	1000 M	c	13.7

TABLE A-2Summary of Gain-Standard Horn Data

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Horns in brackets are scaled versions of each other, excer for the  $l_{\rm H}$  dimensions, which are chosen to make a simple butt-joint at the waveguide

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Fig. A-5 (a). Gain curves

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#### CONSERVICE CHART



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- <b>F</b>	- A	•	<u>A</u> .	t	<u>X</u>	1	À	f (	λ
<u>(=_)</u>	<u>(cn)</u>	(MI)	(22)	(4))	(EZ)	(HC)	<u>(cm)</u>	(#:)	<u>(cm)</u>
1700-	10.02	2300-	10.71		5.52	6426-	4.59	6200-	
こじうぶー	28-57	2:50-	10.53	- K65C-	·e.+1	e450-	4.65	6250-	-3.64
1100-	21.21	2900-	:0.35	4700-	6. 38	6200-	4.62	8 100-	1.61
11:0-	16.07	2950-	10.17	4752-	5.32	4110-	4.54	8356-	3.59
1200-	25.00.	3007-	10.00	- No 21-		2200-	4.55	5400-	1.57
1250-	24.00	30.50 -	9.84	8952-	4.19	0450-	4.51	8+50-	1.55
1300-	25.38	3102-	9.55	4400-	0.12	+100-	4.24	8100-	4.51
1925-	22.22	3150-	9.52	4946-		A750-		8550-	1.51
1-30-	21.43	3266-	9.38	5000-	5.15		4.41	8600-	1.40
1456-	26.05	-256-	9.21	3252-	5.94		5.14	8450-	1 47
1500-	20.00	3362-	5.05	5100-	5.88	. 966-	4.35	5700-	1
1550-	19.35	3350-	8.96	51:0-	5. 13	6950-	4.32	#/50-	1.11
1400-	12.75	1400-	8. 87	5710-	5. 22	7003-	4.24	RADO-	1.41
1410-	18.10	1450-	8.70	5:51-	5.72	7010-	4.26	4650-	3. 39
1792-	17.45	1500-	8.57	5300-	3.88	7100-	4.23	8430-	5.17
1750-	17.14	3556-	8.85	3350-	5.61	7150-	4.20	8950-	3.35
.160C-:	16.+7	3630-	5.33	5400-	5.54	7:00-	4.17	9063-	5.55
1619-1	14.22	5227-	8.22	\$630-	5.52	7250-	8.14	9050-	1.11
1950-	15.74	-0070	#.11	-5500-	5.45	1303-	4.11	9163-	3.30
1450-:	15.38	3750-	8.00	-5550-	5.41	1150-	4.04	9150-	3.28
1030-1	15.00	1603-	7.89	2003-	5.36	7-00-	4.05	9200-	5.24
2030-1	14.63	3:50-	7.79	5630-	5.31	7450-	4.03	9250-	3.24
2100-1	4.29	3400-	7.69	5700-	4.26	7500-	4.00	9300-	5.23
2150-1	13.95	3950-	7.59	5750-	5.22	7550-	3.97	9150-	3.21
2200-1	13.64	4000-	1,50	2900-	2.17	1600-	3.45	9400-	3.19
2250-1	Ŋ.IJ	4050-	7.81	5850-	5.13	1050-	3.92	9450-	3.17
2300-1	13.04	4100-	7.32	- 19:0-	5.08	1103-	3.90	9500-	3.16
2350-1	12.77	4150-	1.23	5950-	5.04	1750-	3.87	9550-	3.14
2400-)	17.50	4200-	7.14	0106-	5.00	7800-	3.85	\$600-j	3.13
2-50-1	12.24	#210-	7.05	A0:0-	4.96	7350-	3.82	4650-	3.11
2500-1	12.00	5J00-	6.95	6100-	£,92	7900-	J. 80	9700-	3.09
12226-1	11.70	4350-	0.90	e150-	3.88	1950-	3.77	9753-	3.08
3600-1	11.54	840C ·	6.82	62-0-	5.84	8000-	3.75	9800-	3.06
26:0-1	11.32	4450-	6.74	\$ 550-	1.80	8050-	3.73	9850-	3.05
2700-1	11.11	#500-	6.67	+365-	1.76	H100-	3.70	9900-	3.03
2759-1	10.41	4550-	8.59	6.150-	£.72	9150-	3.63	9950-	3.02
								:0000-;	3.00

#### Fig. A-5(c). Gain curves and conversion chart











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Fig. A-10. 3.2-cm-band gain-standard horn (2.42-3.70 cm)

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Fig. A-12. 4.75-cm-band gain-standard horn (3.60-5.20 cm)

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Fig. A-13. 6-cm-band gain-standard horn (5.10-7.60 cm)

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Fig. A-16. 23-cm-band gain-standard horn (17.6-26.5 cm)

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