INTERSERVICE RADIO PROPAGATION LABORATORY
NATIONAL BUREAU OF STANDARDS
WASHINGTON, D.C.
Organized under Joint U.S.Communications Board

Presented at
W.P.C.meeting
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CONFIDENTIAL

Report to Wave Propagation Committee on Status of Work of I.R.P.L.

I. Daily Service

A. Data Received from:
1. Beltsville, Md. - NBS Washington data.
2. British Admiralty - Slough data.
3. Naval Service - Ottawa data.
4. U.S.Coast & Geodetic Survey - Cheltenham 3-hr K figs.

B. Data Phoned to:

(1) Navy - (1:30-2:00 EWT) — Washington data (noon, midnight). Plain language report (estimate of disturbance to transmission conditions for previous 24 hrs).

(2) Army - (1:30-2:00 EWT) — Washington, Ottawa, Slough data (noon, midnight)

(3) F.C.C. - (1:30-2:00 EWT) — Washington, Ottawa, Slough data (noon, midnight)

(4) British Admiralty - (immediately) — Washington data (noon, midnight)

II. Weekly Service

Short-Time Forecast.- Forecasts for a week in advance have been issued each week since Oct. 3, 1942. Conditions to be expected are estimated from the combined indications of the immediate solar events reported daily by D.T.M. and from the 27-day recurrence tendencies shown by 13 selected sets of solar, magnetic, ionospheric, and radio transmission data taken from the regions being reported. Complete tabulations and plots on a world-wide basis have been kept of this and all other usable current data pertaining to radio transmission. Arrangements are now being made to obtain reports on ten additional (Navy) radio circuits which will aid further in analyzing actual and predicted transmission conditions.

(over)

III. Monthly and Quarterly Service.

A. Hourly Averages of f^{o}_{F,F_2}, 3000-km m.u.f. Factors.

Received from:
1. Stanford University, Calif.
2. San Juan, P.R.
3. College, Alaska
4. Huancayo, Peru
5. Watheroo W. Australia
6. Ottawa, Canada
7. Washington, D.C. (Beltsville now, Sterling hereafter).

(3, 4, 5) (Phone, DTM)

Above data corrected by I.R.P.L. for:
1. Earth's magnetic field.
2. Time of frequency sweep.
3. Curvature of ionosphere.

Mailed to brief list.

B. Monthly Report of High-Frequency Radio Transmission Conditions, with Predictions for Future Months.

C. Regular Publications and Reports.

1. Most Recent Issue.

A-5: Tables of Frequency Bands Recommended for Use by Ships and Aircraft for Communication with Bases in the Atlantic and Pacific. (July, August, September).

B-3: (Supplementary to A-5) Tables of Frequency Bands for Use by Submarines for Communication with Bases in the Pacific. (July, August, September).

H-2: Frequency Guide for Operating Personnel (July-December, inclusive).

K-4: Tables of Best Radio Frequencies for Use by Ground Stations for Communication with Aircraft or Other Ground Stations in the Atlantic. (July, August, September).

Report: (Limited distribution;- for Lt. Comdr. Hayes and Lt. J.C.Foley): Prediction of Critical Frequencies and Nomograms of m.u.f.s, each 10° latitude, 60°S to 60°N. Predicted for July.

Report: (Limited distribution;- for Col. E. F. French): Predictions for Station WAR; - Best Frequencies for August, 1943.

IV. Special Jobs

A. Issued in Past Month.

Predictions for Lt. Col. Knowles, A.C.: Tabulations of:

1. Maximum usable frequencies for use by airplanes in communication while in flight, with terminal stations of Burma Road, June to September, inclusive.
2. Predictions and nomograms for frequency allocation July - December, inclusive.
3. Sample maps, with transparent world map overlay, giving maximum usable frequencies for all distances and bearings, from 0°, 0200 local time and from 10°N, 0200 local time.
4. (For Lt. Foley): Information on probable distance ranges of low-frequency transmitters from various bases in the South Pacific, as determined by noise levels.
5. One special secret job.
6. Reprint of N.B.S. article "Application of Graphs of Maximum Usable Frequency to Communication Problems," for Navy training class at University of Washington, Seattle, Wash.

B. In Preparation:

1. A-6, B-4, K-5: Predictions already made. Tabulations for publication in process.
2. Report: (Limited distribution.- For Lt. Comdr. Hayes and Lt. W. R. Foley). Predictions and nomograms, each 10° latitude, 60°S to 60°N, for August.
3. I.R.P.L. Radio Propagation Handbook:
   Section I (Introduction), written, first draft.
   Section IV (m.u.f.s), written, first draft.
   Nomograms, maps, etc., about three-fourths complete for entire Handbook.
4. New issue of 1200 copies of A-5 and H-2, to comply with Navy request for more.
5. (For Signal Corps Operational Research Branch): Data for problem of prediction of performance of small army short-distance transmitters in different theaters of war. Antenna performance being calculated prior to use of world maps for prediction.
6. (For Coordinator of Inter-American Affairs):- World maps of observed m.u.f.'s; paths being laid out for a preliminary check of past performance before prediction.
7. Report for I.S.I.B. on prediction method. (Rough draft).
8. Report for I.S.I.B. on L.A.Boyd expedition data. (Rough draft).

V. Basic Data Analysis

A. Preparation of Washington Data.

1. Scaling N.B.S. multifrequency records for f^{o}_{F,F_2}, h_{F,F_2}; $f^{o}_{F_1}$, h_{F_1}; f^{o}_{E}, h_{E}; E_s.
   3500-km, 1500-km m.u.f.s for F, F_2 layer.

2. Diurnal curves, each day, f°_{F,F_2}, h_{F,F_2}, $f^{\circ}_{F_1}$, h_{F_1}, f°_{E}, h_{E}.
3. Hourly tabulations, each day, of data of (1), also 3500-km F,F_2 m.u.f. factor.
4. Monthly averages, total, disturbed, undisturbed, for data of (3).
5. (a) 5-hr averages (23, 00, 01, 02, 03), (11, 12, 13, 14, 15), of f°_{F,F_2}, h_{F,F_2}.

   (b) 30-day running averages, data 5(a).
6. I-figures each Greenwich half day, using (5) indicating relative ionospheric storminess. Ionosphere storms selected.
7. Tables, graphs Washington data prepared for reporting service.

B. Status of Basic Data Correlation.

A. Work completed on correlation of past data:
   1. Correlation used in present type of predictions:
      (a) 1. Tabulation and plotting curves of $f^{\circ}_{F_2}$, $f^{\circ}_{F_1}$, f°_{E}, f_{min}, h_{F_2}, h_{F_1}, h_{E}.
          2. 12-month running averages of monthly average for
             (a) every 4 hours, also D.M. $f^{\circ}_{F_2}$.
             (b) noon f°_{E}, $f^{\circ}_{F_1}$.
          3. Correlation curves (2) with 12-mo. running averages of monthly average sunspot numbers.
          4. Ratios of seasonal averages for data of (2) to running averages; correlation of these ratios with sunspot number.
          5. Ratio monthly average to seasonal average; correlation of these ratios with sunspot number.
          6. Plots of monthly averages of $f^{\circ}_{F_2}$ vs time, each 4 hurs.
             (a) continuous,
             (b) segregated months.
          7. Diurnal percent range of $f^{\circ}_{F_2}$ - D.M.
          8. Diurnal percent of noon f°_{E}.
          9. Diurnal percent of noon $f^{\circ}_{F_1}$.

      (b) Computation of m.u.f. factors, each hour, also monthly average, all stations where data given.
      (c) Sporadic E.
          1. Diurnal probability of occurrence in classes: > 3 Mc, > 5 Mc, > 7 Mc, all stations.
          2. Plots of (1).
          3. Plots Washington Sporadic-E to show variation of sporadic-E with sunspot cycle.

   2. Auxiliary computations, etc., for use in reply to special requests, etc.:
      (a) Solar data.

1. 12-month, 7-cycle, 3-month, 7-day moving averages sunspot numbers; plots vs. time.
2. Sunrise, sunset times, each month, each 10° latitude, each cooperating station.

(b) Geographical data pertaining to great-circle paths.

1. Nomograms for solution of problems for distance, bearing, solar zenith angle.
2. Great-circle maps, each 10° latitude, small circles in km, statute miles, nautical miles.
3. Plots of ionosphere control points for distances 250 miles -2500 miles, both mobile unit to base, base to mobile unit for bases each 10° latitude, also for requested Navy, Air Force bases.

(c) Absorption data.

1. Distance range-frequency curves, noon, midnight, each 10° latitude, each month.
2. Diurnal distance range variation, each 10° latitude.
3. Auroral absorption variation with time, latitude.
4. World absorption maps, each month.
5. World distance-range nomograms, each month. (Also, more precise nomograms for 40°N).
6. Nomograms for rapid estimation of average path absorption.
7. Nomograms $A - kS_0 - d$.
8. Nomograms $I_{antenna} - f - h - P$.
9. Nomograms distance ranges for ground wave.
10. L.u.h.f. - m.u.f. - c.w.f. nomograms.

(d) Variation m.u.f. with distance.

1. Curves, tabulations, nomograms both E and F layers.

B. Work on basic data in progress.

1. Extension of predictions.
   a. Correlation of f_{min}, h_{F_2}, h_{F_1}, h_E, in manner of A1, 2, 3, 4, 5, 6, 7.
   b. Statistical analysis data.
      1. 5-hr. averages $f^0_{F_2}$, h_{F_2} centered about noon, midnight.
      2. Distribution curves BIb1.
      3. Distribution curves 00-12h, 12-24h.
         K figs. to correlate with BIb2.
      4. Computation standard deviations, relative skewness, relative kurtosis, of above.
      5. Tabulation distribution $f^0_{F_2}$ each half Mc, each hour, all available data.
      6. Computation BIb5 into diurnal probabilities of continuous transmission.
      7. Combination of AIc1, BIb6 into combined probabilities continuous transmission.
      8. Extension BIb7 to other than 0 distances.
2. Auxiliary computations, etc.
   1. Nomograms for distance range on ultra-high frequencies.

C. Absorption Data.

For the general study of the degree of absorption of radio signals in various latitudes and at various frequencies, detailed measurements of automatic radio field-intensity records are made. Hourly values of the median field intensities of 933 months of records obtained during the last six years from 59 stations ranging in frequency from 660 kilocycles to 15,330 kilocycles have been measured, tabulated, and averages computed. Diurnal curves of average hourly characteristics for each month were prepared and used to judge the quality of records. Records from 26 stations were selected as especially suitable for the study of monthly and yearly absorption trends. Results have been obtained for 5 megacycles for some latitudes, and are now being calculated for other frequencies and latitudes.