50 Years of Progress—A Report on Amateur Radio

With Special Reference to the New Philosophy of Integers

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IT IS CUSTOMARY at the midpoint in a century to take inventory on progress, and it is a real pleasure when the field is amateur radio. While it is true that *QST* and other amateur journals have occasionally mentioned a few of the amateur contributions to the art of communication, the author has anticipated the need for a factual report that can be added to the similar works in other fields. The present paper is the result of 23 months of steady work, sifting the inconsequential from the significant and reducing the findings to definite argot.

Early in the work it was decided to confine the investigation to those problems peculiar to amateur radio and not duplicated in other communications fields as, for example, point-to-point, mobile, entertainment (including television and broadcasting), and diathermy. It was felt that such a report would show clearly the great strides made by radio amateurs, working silently in their basement workshops and attic laboratories. The work involved in preparing this paper was made difficult by the characteristic reluctance amateurs show in talking about their achievements, while quick to acclaim the work of a colleague, despite the low power and poor antenna location of said colleague. However, free-and-easy access was obtained to thousands of well-kept logbooks and other records, and many of the heuristic conclusions were reached only because this information was made available.

Amateur communication can best be studied by breaking it down into three parts which, for simplicity, will be called Part 1, Part 2, and Part 3. Other designations might be used, of course. These three parts will be found, upon close inspection, to be (1) the quality or "tone" of the signals involved, (2) the "readability" or Q factor of the signals, and (3) the "strength" of the signals. Let us examine them in detail.

Part 1—Tone

Early records clearly show that from the first days of amateur radio, at the turn of the century, there was a noticeable difference in the tones of signals emanating from different transmitters. This effect was marked enough to suggest to the early experimenters that the most logical system of amateur communication was simultaneous operation of many transmitters on the same frequency, or "wavelength" as it was known in those days, with the receiving operator skillfully utilizing the differences in tones to select aurally the desired signal. This system was found to work very well with one transmitter operating in any given area, or with one weak and one strong station, if the strong station was the desired one. This system was carried through into the middle '30s, with the accepted wavelengths, or "frequencies" as they had become known, being carefully selected to coincide with the amateur band limits, or "edges."

As interest grew in the "tone" of the signals, a scale was devised [1] to enable a receiving operator to report to the transmitting operator just what the tone of the signal was or should be. Cautiously named the "T" scale, it consisted of careful descriptions of the common types of signals in vogue at the time, numbered from 1 to 9 for easy identification. The records indicate that no amateur in the past 50 years has ever been complacent enough to stop short of perfection in the tone of his transmitter's signal, as is apparent by the sheer horror registered by an operator who receives a "T8" report, although by the accepted scale it is a legal signal and not far from perfect. It is rare indeed to hear a pedicular signal reported as "T7" or "T6," so great has been the technical progress of amateur radio. By checking back on transmitter designs, computing the transmitter waveform and modulation characteristics, and plotting these against tabulated reports recorded in logbooks, it is possible to reconstruct the entire picture. Fig. 1 is a plot of the progress in amateur tone reports, and no further comment

• We are fortunate this month in being able to present this significant work by the accepted authority in the field. The original calculations have been checked by our editorial staff and confirmed, but they are omitted from this presentation in the interests of national security.

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[1] Krausmeyer, "Why Not a T Scale?," *Journal of Applied Physics*, April, 1924; Rabinowicz, "Yes, Why Not?," *Proc. I.R.E.*, Sept., 1924.

is necessary. Study it carefully — it is a glorious record of achievement.

Part 2 — Readability

The readability or "R" factor is a direct indication of the ease with which a signal can be copied, based on a scale of 1 to 5. When the scale was first introduced,[2] it was not unusual to hear readability reports of "R3" given to signals masked by noise or interference. However, despite increasingly-crowded bands, the accepted and taken-for-granted report is "R5," which means "Perfectly readable." The report of "R4," defined as "Readable with practically no difficulty," is reserved only for rare occasions when the signal is completely smothered by interference. It is, however, a true report, because the receiving operator will always acknowledge one of these smothered Readability 4 transmissions with "R OK, solid, FB," and other popular expressions. To the average bystander, such operating skill is beyond all comprehension, and naturally he never bothers to ask the receiving operator what was copied so solidly. After all, there is nothing like respect for genius.

[2] H. RES. 2751, Sept. 9, 1935, 74th Congress, 1st Session.

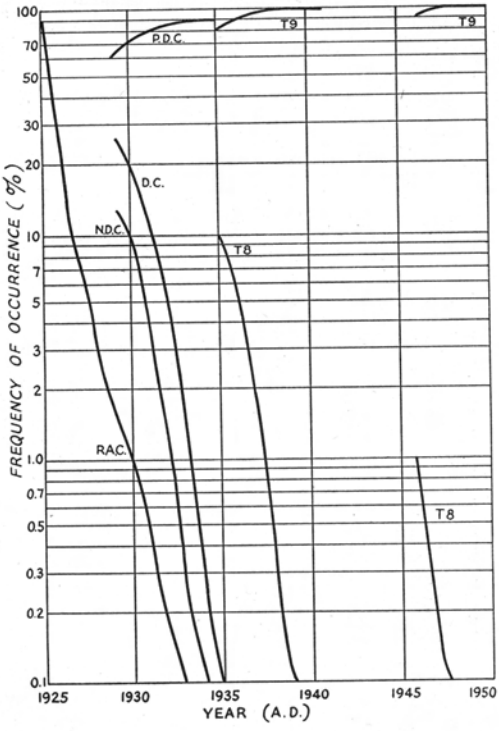

Fig. 1 — A plot of the frequency of occurrence of tone reports plotted against time. World War II and changes in reporting methods and government regulations account for the discontinuities.

The steady growth of T9 (earlier "P.D.C.") reports is in sharp contrast to the rapid falling off and eventual disappearance of less complimentary reports.

To the uninitiated, or newcomer to amateur radio, it is sometimes difficult to arrive at an exact readability report. There is no need for this if he follows one simple rule. The following equation, arrived at empirically after months of investigation, will give the correct report in every instance. For any given band and set of conditions, the readability report is given by

$$R = 2.5\left(2 - \frac{n}{f}\right)$$

where n = number of signals on the channel, and

f = operating frequency in Mc.

R is always given in the nearest whole number.

Part 3 — Signal Strength

Tabulation of the signal reports received by active stations during the past 50 years shows clearly the great advances that have been made. Despite no relaxing of the legal power limit by FCC and other licensing authorities, the average report has slowly climbed to its present exalted heights. Considering only the present "S" scale, based on values from 1 to 9, it is interesting to note that in the middle '30s it was not unusual for stations to carry on communication with "Strength 3" or "Strength 4" signals at each end of the circuit. Nowadays, however, through antenna developments and circuit refinements, the *average* level of signals is up around S7 or S8, with no change in the transmitter power.

As usual, the radiotelephone specialists, generally acknowledged to be more advanced than the so-called "c.w. men," have brought the improvement in efficiency to still greater heights. Most of their reports take the form of "20 db. over S9" ("S9" means "Extremely strong signals"), and some reports run up to 40 or 50 db. over S9, with preselector. The average nonamateur, with a little mathematics and engineering knowledge at his command, is hard put to explain a signal that has 100 to 300 times the field strength of an extremely strong signal, but such profound knowledge can only be acquired after many years in the field. It even has some of the c.w. men guessing, and studying antenna theory.

Another effect observed only by amateurs, but thoroughly attested to by their records, is the "QSL" or "DXCC" effect. To the layman, this can be stated simply as being "the increased strength a signal has when it originates from a country where there are relatively few amateurs." Odd as it may seem to the uninitiated, it can be proved definitely that a given field strength at a receiver will result in a louder signal out of the receiver when the signal originates in a rare country than when it comes from a domestic station. The effect is still under study, and no real con-

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clusions have been reached beyond the fact that the phenomenon exists. But remember — amateurs noticed it first!

Neophytes will be interested in simple equations that can be used to determine S reports when working a country from which they have no QSL card, thus eliminating any guesswork or personal factors. After thorough study and two weeks use of the autocorollator and the differential analyzer made available through the courtesy of M.I.T., the following relations were derived. DX signal strength reports can be determined by

$$S = 6 + N/33 \qquad \text{for } N<100$$
$$\text{or } S = 7 + (N - 50)/75 \qquad \text{for } 100<N<200$$

In either equation, N = number of countries confirmed by card. S is given in the nearest whole number.

Conclusions

The history of amateur radio is a glorious one of 50 years of progress. A proud history, and who knows what the next 50 years will bring? Surely we need new fields to conquer.

How's DX?

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New York City, N. Y. . _ . _ . _ W4BYF has good news from PJ5TR. Liberalization of amateur regulations in Curacao is anticipated in the near future. W8WWU got quite a bang from being PJ5KG's first QSO, the latter employing a freshly-homebrewed rig . _ . _ . _ LZ1ID/XX is still sending cards through as W9AND will attest and, in a P.S., the fellow lays claim to being the only ham in Bulgaria (and strictly under cover) . _ . _ . _ PK1RI tipped off W8DAW anent a PK1 QSL bureau as "% Factory, Djakarta, Indonesia," while ZD4AU would like to clear up his QSL debts as W1IKE is informed and may be reached in this respect as follows: J. L. Speer, Opns-Joburg, Mail Clerk, Pan-American Airways, LaGuardia Field, N. Y. . _ . _ . _ Ex-F9QU/FM8, now FM7WE, vows to lick his QSL backlog and wishes his W contacts be patient, says W4PJU. We'll cast about for some info concerning the new switches in French Colonial prefixes (numerals) although it appears a matter of small importance since alphabetically they are still fairly consistent . _ . _ . _ HB9JJ will put HE1JJ on the air April 7th through 10th and will try to give 3.5-, 7- and 14-Mc. c.w. a try as well as 3.5 and 7-Mc. 'phone. Charly is a 100%-QSL man and you may fire him cards direct or via USKA.

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W9s OLU and TO express considerable curiosity as to what country the prefix EX1 represents inasmuch as so many QSLs from EX1T are to be noted adorning the doorways of public buildings. He's a new one to us, we'll admit, but savors a reminiscence of the PR1VVY confirmations tacked up on shacks in rural areas, now less often seen.

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more fun to a low-power job than with the big ones. For me the difficulty lends enchantment and the kick when some remote bird comes back is greater because of the low power.

Now it is not easy but there are tricks one can use. A VFO is essential and break-in is essential. You gotta stay away from the pile-ups where a lot of high-power boys are fighting each other. You must pick clear spots in the band, and you must know which band to use at what times of day. Many is the time I have run away with some DX by calling a little below or above the pile-up and thus I leave the h.p. boys to fight themselves to a standstill while I QSO the DX.

Another thing you must do is to go to bed early and get up early, say 8 P.M. and 2 A.M., if you want DX. Then the local boys are tired out with their h.p. fights and the little pip squeak you operate has a chance.

So the low-power boys can do it too!

— Keith Henney, W1QGU/K2BH