fine tuning's

PROCEEDINGS 1994-95

COVER DESIGN

The recently discovered *radiopetroglyph* depicted on the front cover incorporates an image computer-enhanced by Guy Atkins. Were the ancient Anasazi indians of the Southwest U.S. onto something? Leading theorists speculate that a form of "border radio" may have predated Marconi and deForest by many centuries

International Book Standard Number application has been filed.

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Welcome to *Proceedings* 1994-95! We are sure that you will find this edition of *Proceedings* as enjoyable and helpful as those in the past. This year, we have several articles that are quite unusual for us.

For the first time, we have a scientist writing about propagation. Dr. Robert Brown is a widely respected expert on the ionosphere, particularly in polar regions. His article on the development of our understanding of propagation of radio waves via the ionosphere has been extraordinarily helpful to those on our Review Board who reviewed it.

The last article in this edition is also unusual. Mark Connelly has been the most prolific DXer of Trans-Atlantic (TA) medium wave signals during the past decade. Mark's article on TA DXing is surely the finest of its type ever published. It is so informative and will be of such value to anyone wishing to try their hand at TA DXing on MW that we are publishing it in *Proceedings*, even though it is being published more or less simultaneously in the MW hobby press.

Each of the other articles should also prove interesting and useful to each reader. David Clark, this time with new coauthor Tony Ward, continues the series on Tropical Band propagation. That is followed by a group of antenna articles which, together, will be helpful to any radio enthusiast, whether they DX from an urban apartment or a 180 acre antenna farm.

The Receiver section of this edition is the largest we have ever published and covers receivers manufactured from 1937 to the newest top-of-the-line Watkins-Johnson HF-1000. We think that you will find these reviews very interesting and thought-provoking.

As you will note, we only review one piece of peripheral equipment this time, an HP-45 calculator which Tom Napolitano has shown to be a very effective "computer" controller for modern communications receivers. We feel that Tom's invention is a real breakthrough which will be as interesting to receiver manufacturers as it is to all of us.

Along with the Connelly MW DX article, the Features section contains useful articles on a wide variety of subjects. One reviewer called Bob Eldridge's article on noise management/avoidance "the most important article that *Proceedings* has ever published." We are also indebted to John Fisher for trying to decipher and record the rapidly changing SWBC scene in Russia. John's article will be an important reference for many of us in DX seasons to come.

Collectively, we owe a large debt of gratitude to the authors of *Proceedings* 1994-95. The writing of this edition along with the editing and production has been far more of a struggle than ever before. From our discussions with authors, it seems that the current fad of "down-sizing" of large organizations in the U.S. and Canada has really affected the free time of many of us. This year, for the first time, several of our authors actually used vacation days to complete their articles. This year, again for the first time, several authors had to drop out during our yearlong production cycle. More that ever before, each of us owes a debt to our fellow radio enthusiasts who gave precious hobby time to share their expertise with the rest of us through these pages.

DESKTOP PUBLISHING ARRIVES

If you have each edition of *Proceedings*, you will note that we have improved the clarity and organization of the printing with each succeeding issue. By the 1992-93 edition, every article was word processed and printed in approximately the same typeface via several different laser printers. That step materially improved the legibility of the articles. However, the variety of typefaces and laser printers still left the book somewhat chaotic and tiring to read. This year, all articles were sent to a central word processing point where keyboard artist Rochelle Atkins put each article in the same type face and general format. At that point, Guy Atkins took over and applied his considerable talents through PageMaker DTP software. All master pages were then printed through the same laser printer. Guy deserves real kudos for the numerous charts in several of the articles. He spent many long hours making those a real pleasure to read. We think that you will agree that *Proceedings* 1994-95 is the most legible, cohesive edition that we have produced. The entire Atkins household deserves a big round of applause from us all. WELL DONE!

COSTS AND SUCH

Regular readers of *Proceedings* will probably have noticed that we have, very reluctantly, raised the price from $19.50 to $20.50. This is our first book price increase since 1989. During the five years since '89, our average printing cost per book has increased by $2.00. Other costs have also gone up slightly as well. Since we must reprint old editions of *Proceedings* as past printings sell out, we are forced to raise the price of those editions, as well. We regret this modest increase, but we have no choice if we're to remain on a "break even" basis. As in the past, each of our staff continues to serve in their editorial and management roles without pay. Further, the staff, reviewers and authors each purchase their own copies of *Proceedings* at full price. We do, however, pay for some of the more laborious chores of shipping and some other general services which we cannot perform with volunteer labor.

BOOKS, BOOKS, BOOKS

Proceedings seems to have become a "midwife" for a number of forthcoming books. Many of you will have received a flyer about the new *Zenith Trans-Oceanic, the Royalty of Radios* by John Bryant and Harold Cones. Not only have they completed this definitive work on the Trans-Oceanic, they have recently signed with Schiffer Publications to author a series of Zenith-related books over the next several years. We are pleased to note that Harold and John first wrote together in the 1988 inaugural edition of *Proceedings*. Chuck Dachis, the Hallicrafters Collector featured in the 1989 and 1992-93 editions, is in the final stages of producing what will certainly be THE definitive book on Hallicrafters. Elton Byington has also signed a contract to write a book on the history of communications receivers. Several other radio enthusiasts who have written for *Proceedings* are in the beginning stages of book authorship. It is gratifying to see the qualities which have been *Proceedings*' hallmarks begin to spread beyond our own pages.

"SINGLE SUBJECT" BOOKS

We have had a number of requests for single article reprints and for subject-specific collections of articles from previous editions of *Proceedings*. For instance, it seems that many radio enthusiasts would like to have access to all of the receiver articles, but they may have no real interest in the other articles in each of our issues. Over the next year or two, the staff will be exploring the possibility of publishing collections of past articles about tube-type receivers, solid state receivers, wire antennas and possibly, propagation. If we publish these "single-subject books," please note that they will contain PAST articles, not new ones.

FUTURE PLANS

At this point, the publication date of the next *Proceedings* has NOT been determined. As mentioned previously, many of the authors and all of the staff of this edition found the production of this volume very difficult. The trend of business down-sizing and the generally accelerated pace of life of the mid-1990s seems to have materially reduced the leisure time of many of us. It is quite natural that folks in such a situation would wish to devote more of their time to involvement in active radio pursuits. This is certainly the case with the *Proceedings* Staff. At our annual staff meeting in August 1994, we unanimously decided to postpone publication of the next *Proceedings* for an indefinite period. We also decided to reexamine this decision each August. We each look forward to the time in the not too distant future when we will begin again the year-long production cycle of the *Proceedings* of *Fine Tuning*. In the mean time, thanks once again to each person who has contributed to the production of these volumes and to each radio enthusiast who has enjoyed the articles between these covers.

John Bryant | Fritz Mellberg | Guy Atkins | David Clark

editorial process

editorial process

Since the editorial process of *Proceedings* is unique in hobby journalism, it might be of some interest to readers. First, where do the authors and articles come from? Mostly, the are recruited by the editorial staff, though some of our very best articles also come from volunteers or arrive unsolicited. Authors submit rough drafts in March of each year of publication. Those rough drafts then take a twin track through the editorial process. One track runs straight through downtown Cedar Rapids, Iowa, where Fritz Mellberg edits all rough drafts for style, conciseness and clarity. The authors and Staff call Rev. Mellberg "Fritz the Chopper." A journalist before answering a higher call, Fritz is responsible for helping us communicate intelligibly with each of you. Fritz has been of immeasurable help in improving each of our writing styles. Please note, however, that Fritz works his magic at the Rough Draft stage! Since many of the articles are extensively rewritten for the Final Draft, grammatical errors, a few typos and some few instances of murky style creep back into the published articles. As with most scholarly journals, each author is entirely responsible for those matters in the final draft. We have found it impossible even to think of adding another round of editing, correcting and reprinting Final Drafts to our already labyrinthine process. We hope that you will understand and forgive us a few imperfections.

The second editorial track for Rough Drafts runs through Stillwater, Oklahoma. There, John Bryant assigns six or so members of the Editorial Review Board and at least two of the four Staff to review each article. John assigns these review responsibilities very carefully. He selects one or two members of the Review Board for their own expertise in the subject matter of that article; he chooses several to represent the "average" reader and one who neither knows nor cares much about the subject at hand. The Editorial Review Board is responsible for maintaining the standard of excellence for which *Proceedings* is known. Each year a few articles are withheld from publication to allow the author more time to develop the subject. The second and probably more important role of the Review Board is to assist each author with constructive suggestions and comments so that the final article may have the benefit of the ideas of several experienced DXers. Most authors perform major revisions and incorporate many of the Board's suggestions and Fritz's markings in their final draft.

Service on the Editorial Review Board is a difficult and thankless task. Each member must sit in sometimes rather harsh judgement of work done by fellow radio enthusiasts. The work of the Board is time consuming and must be done to a short and very rigid time schedule. *Proceedings* as an institution and each of its readers owes a very real debt to the members of the Review Board. The "peer review" process of *Proceedings* is, we believe, unique in hobby journalism. We patterned our process on the quality control peer review system used by most respected scholarly and learned publications. We believe that this elaborate, expensive, and rather ego-deflating process insures that the articles finally published in *Proceedings* are truly the best the hobby has to offer. We hope you agree.

Guy Atkins has staff responsibilities for all of our publicity, including creating the very striking and legible announcements and press releases that you have seen published in recent years. This year, Guy and his wife Rochelle are also responsible for all of the desktop publishing work that will be so noticeable in this edition of *Proceedings*. Their very professional work is a source of pride for the entire Staff. Guy also alternates with John Bryant as designer of the front cover and has created this edition's beauty. John Bryant continues to be our straw boss or quarterback or `designated worrier', running the finances and generally overseeing operations. However, John wants it known that as *Proceedings* has matured, editorial decisions, big and small, are almost entirely made by the collective Staff. Except for the still computer-less Fritz, we are all in almost daily contact via Compuserve E-mail during the nine-month long gestation period of each edition. *Proceedings* is truly a collective effort.

EDITORIAL REVIEW BOARD

about fine tuning

about fine tuning

fine tuning is an organization dedicated to supporting the hobby of Shortwave Broadcast DXing. Founded in 1977 by well known DXer Dan Ferguson, FT originally published a bi-weekly newsletter of rare and difficult DX heard by leading shortwave enthusiasts throughout North America. To shorten the time between reception and publication, and to keep the work load manageable, membership in *fine tuning* was kept small and "by invitation." After several years, Dan turned over the editing and publishing chores to Larry Yamron who continues to serve as *FT's* publisher. In 1986, FT merged with the *Ozark Mountain DX Club*, a fully public DX newsletter founded and published by Mitch Sams. Mitch is now the Managing Editor of *fine tuning*. With the merger, FT adopted the "open organization" philosophy of OMDXC and continues to day to welcome all radio enthusiasts interested in rare and difficult DX. Also in 1986, FT established its Special Publications arm led by John Bryant.

THE NEWS LETTER

The newsletter portion of *fine tuning's* services is published weekly during the DX season and bi-weekly during the North American summer. The newsltter, also called *fine tuning,* is a jounal emphasizing rare and difficult DX. The bulletins feature SWBC news but also contain news of unusual merit from the medium wave, long wave, ham, utility, or TV DX communities.

There are three people currently involved in the production of the weekly issues of *fine tuning*. Three outstanding DXers serve as editors, each being responsible for two issues before handing off to the next editor. The weekly editors are: Dave Valko, Larry Yamron and Mitch Sams. They are supported by Back-up Editor John Wilkins. Managing Editor Mitch Sams also maintains FT subscriptions, finances and responds to sample requests. Publication of FT is handled by Larry Yamron. Each completed issue of FT is mailed from the current editor to Larry for publication and Mailing.

Cost (US) per issues of the *fine tuning* bulleting is 65 cents per issue in the US, 70 cents per issue in Canada and 80 cents US for Airmail overseas. Minimum order of 30 issues is payable to:

FINE TUNING, c/o Mitch Sams, 779 Galilea Ct., Blue Springs, MO 64014, USA.

Sample copies of the *fine tuning's* newsletter may be obtained from Headquarters in Blue Springs for $1.00 US.

SPECIAL PUBLICATIONS

The Special Publications of *fine tuning* was established in 1986. This arm of the organization has published a number of well received, geographically-oriented *DXers Guides*. The *DXers Guide to Latin America; The DXers Guide to Indonesia; The DXers Handbook: Indonesia* and the bi-annually published FT/OZDX *Survey of SWBC Activity in Indonesia*. However, the main effort of Special Publications is the publication of the widely acclaimed *Proceedings* of *fine tuning*. *Proceedings* is a now biennial collection of in-depth articles and papers on all aspects of radio. Although its main orientation is toward the SWBC DXing community, *Proceedings* intentionally serves as a bridge for cross-fertilization of knowledge from MW DXing and the radio amateur community. Currently, Special Publications is committed to maintaining stocks of all back issues of *Proceedings*. Further information on *Proceedings* or other FT Special Publications may be obtained for an SASE from:

Fine Tuning's Special Publications
c/o John Bryant
Rt. 5, Box 14,
Stillwater, OK
74074 USA

propagation

A BRIEF HISTORY OF IONOSPHERIC STUDIES

Robert R. Brown, NM7M

Editorial Note: The following is certainly the most scholarly propagation article yet published by *Proceedings.* This is not surprising because Bob Brown, NM7M, is also Dr. Robert R. Brown, Emeritus Professor of Physics, University of California, Berkeley. Bob spent a career as high latitude geophysicist focusing on the structure and behavior of the polar regions of the ionosphere when under bombardment by auroral electrons and solar protons. Since his retirement, Bob has become a widely acclaimed columnist in several magazines where he shares the knowledge of ionospheric researchers with radio enthusiasts throughout North America. The following article outlines our understanding of the ionosphere as it developed over the last century. It also describes our current view of this highly complex medium and describes the directions of current research. The article is written in terms familiar to every professional working in the field today. However, unlike most scholarly papers, Bob has carefully defined each professional term the first time that it is used. This article deserves careful study by every radio enthusiast interested in long distance radio. It will provide all but the most casual reader with a much clearer picture of the ionosphere and how it behaves.

INTRODUCTION

At this late date in history, almost 100 years after the first observations of radio propagation, we can look back to see where we've been and look ahead to where the interesting developments will be taking place. At present, we're in the "plasma and fields era", the ionosphere now recognized as being but one part of a coupled system, thermosphere-ionosphere-magnetosphere, which finds its origin at the sun. Thus, we're learning about the top-side of the ionosphere and its interaction with regions inward and outward. But our interest in communications is really tied to the first 50 years of radio, the exploration of the ionosphere below the peak of the F-region and what might be termed the "photo-chemical era".

In that earlier era, it was shown that the ionosphere consists of free electrons, positive ions, atoms and molecules, resulting from photo-ionization and photo-dissociation by ultra-violet (UV) radiation from the sun. There was one complication, however; the ionosphere is immersed in the earth's magnetic field which constrains electrons and positive ions to gyrate around the local field lines. As a result, the local properties of the ionosphere are no longer identical in all directions and radio propagation varies with direction relative to the geomagnetic field, particularly at lower frequencies.

Theoretical discussions showed that inertia and magnetic forces on electrons affect their motions when exposed to radio waves and that results in propagation which is frequency-dependent. In particular, the way in which a radio wave propagates through the ionosphere depends on how its own frequency (F) compares with several other frequencies determined by the local properties of the medium itself.

The most important frequency for propagation purposes is the local plasma frequency (fn) which depends on the number density of electrons at a given height. The

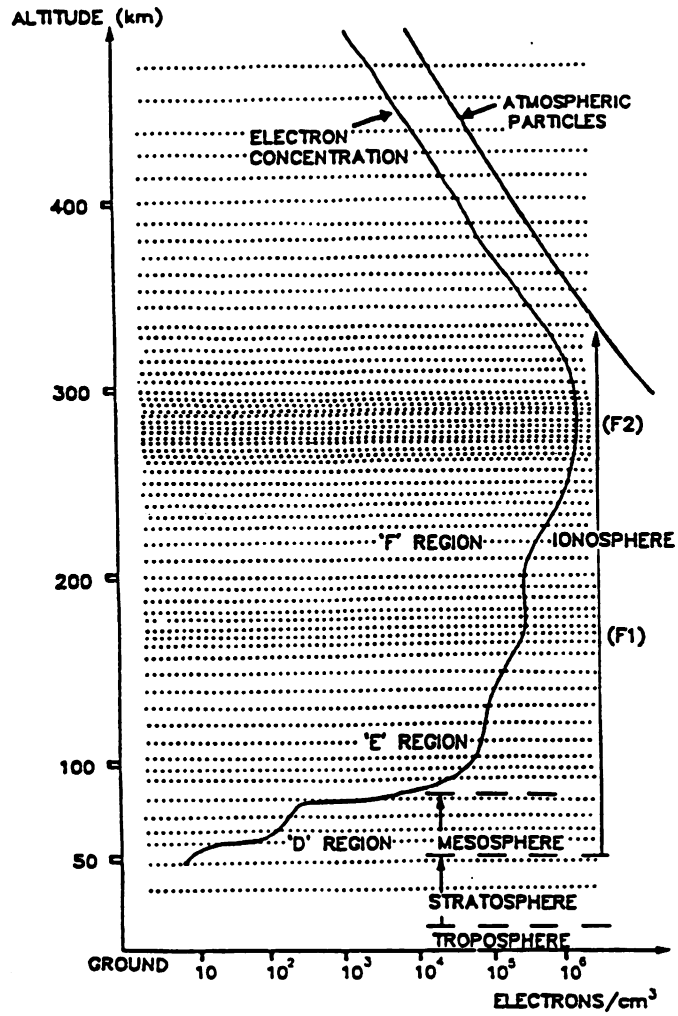

Figure 1 - Daytime variation of the electron density with altitude. (From McNamara, 1994)

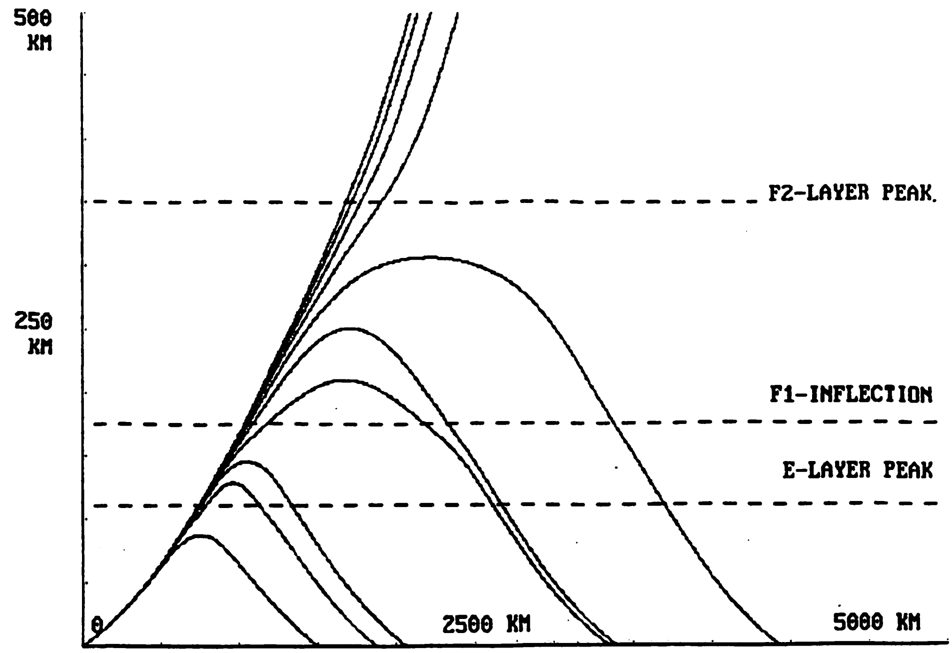

Figure 2 - Refraction and penetration of the ionosphere by waves from 3 to 30 MHz in 3 MHz steps.

collision frequency (fc), giving the rate of collisions between electrons and nearby constituents, is another one. Finally, there's the electron gyro-frequency (fH) which gives the rate at which electrons spiral around the local field lines. To put the various frequencies in perspective, the plasma frequency fn ranges from 3 to 15 MHz over the earth, the electron collision frequency fc ranges from 1 to 10 MHz with decreasing altitude and finally the electron gyro-frequency fH averages about 1 MHz at ionospheric heights.

As to the significance of those frequencies, signal absorption depends on the electron collision frequency in the lower ionosphere, the plasma frequency determines the frequency limit for successful propagation on a path while a comparison of the electron gyro-frequency and the signal frequency determines the extent to which the ionosphere is anisotropic, waves propagating differently according to direction relative to the magnetic field and polarization. At the upper end of the HF spectrum (3-30 MHz), the plasma frequency is the most important of all three while the collision and the gyro-frequency dominate at the lower end of the range. So much for the theoretical formalities.

On the experimental side, the historical record shows that our knowledge and understanding in the photo-chemical era proceeded outward in direction and upward in frequency. Thus, we came to know the first hundred kilometers above the earth, now termed the D-and E-regions of the ionosphere, are largely controlled by the degree and duration of solar illumination. In the course of time, the frequencies in common useage rose into the HF range, 3 to 30 MHz, and our radio experience touched even higher and different regions, say the two parts of the F-region. With that, it became apparent that the sun played an even larger role, affecting growth and decay of ionization in the F-region in different ways than at lower altitudes and also by its slowly changing activity, as judged by the rise and fall of sunspot counts in its cyclical behaviour.

Beyond that, more dynamic influences of solar activity became evident in the first 50 years, sudden ionospheric disturbances (SID) on the sunlit side of the earth affecting the D- and E-regions with solar flares, D-region black-outs of propagation across the polar caps following larger and more energetic solar flares and even global disruptions of F-region propagation with geomagnetic storms. While a good fraction of those sporadic disturbances occurred close to or within the peak activity in the solar cycles, they were not limited just to those times, thus adding an element of unpredictability to HF radio propagation that was not there at lower frequencies. So much for the early history.

HF PROPAGATION

While the formation of the ionosphere is of interest to those working in physics and chemistry, others who follow communications are more interested in when propagation takes place and how it would be disturbed by external influences. Of course, the "when and how" of propagation follows from electromagnetic theory, wave refraction by an

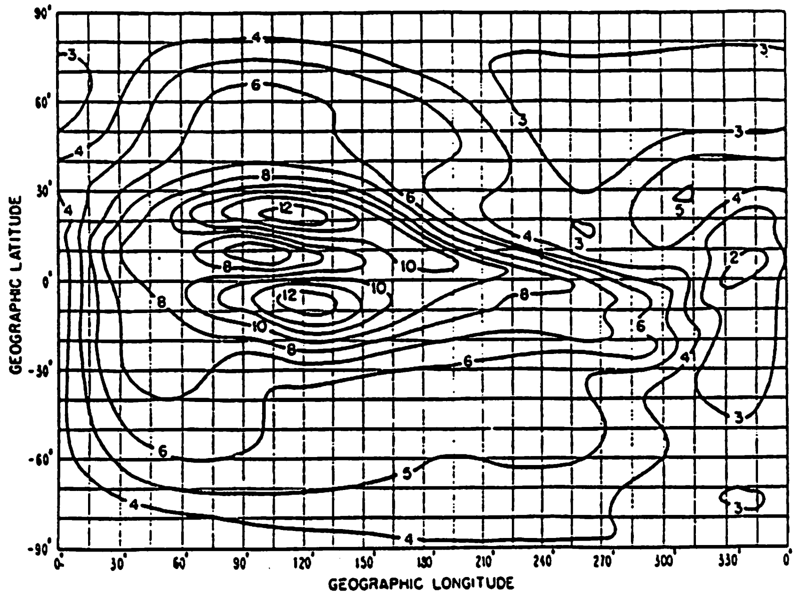

Figure 3 - Global foF2 map for March 1976 at 0600 UTC (From Davies, 1990)(The sun is located at 90° longitude and 0° latitude)

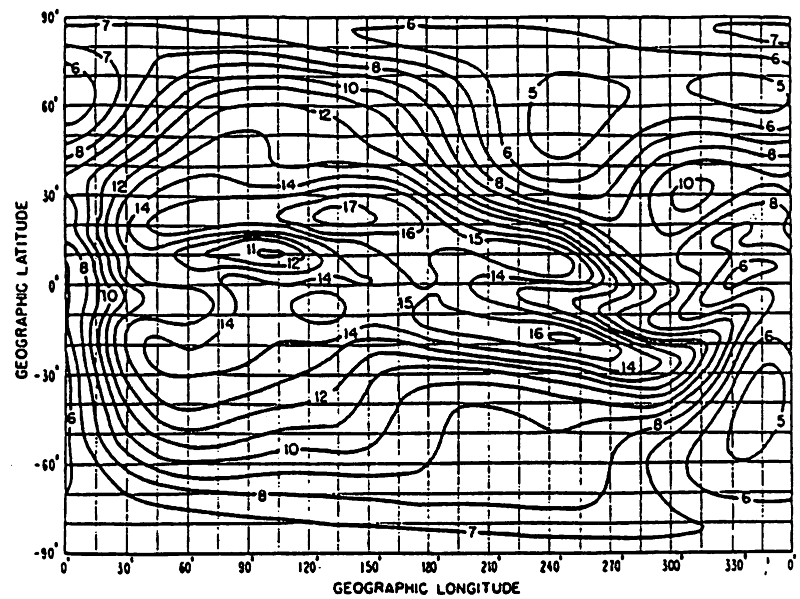

Figure 4 - Global foF2 map for March 1979 at 0600 UTC (From Davies, 1990) (The sun is located at 90° longitude and 0° latitude)

ionized medium, as well as the global distribution of ionization at a given time. An excellent discussion of those ideas can be found in the new book, Radio Amateurs Guide to the Ionosphere, by Dr. Leo McNamara (Krieger Publishing Co., 1994).

A complete treatment of oblique ionospheric propagation would require not only a full mapping of the limiting or critical frequency for reflection at vertical incidence (foF2) as a function of latitude, longitude but also the date, time of day and sunspot number. Beyond that, each foF2 map would require details of the vertical distribution of ionization throughout the various regions. By way of illustration, a representative electron density profile is shown in Figure 1.

Without being too specific, it is safe to say that for waves of a given radiation angle, the distances covered on propagation paths are greater the higher the frequency until the waves penetrate the layer and escape. This is illustrated in Figure 2 where ray-tracing has been used for (ordinary) waves launched at a 5 degree radiation angle, the HF frequency range (3-30 MHz) being covered in steps of 3 MHz for a simple F-layer with foF2=6 MHz. Here, it is seen that the lower frequencies do not penetrate the ionosphere as much as the higher ones, particularly near the critical frequency for penetration.

In the late '30s, those ideas lead to the concept of a maximum useable frequency (MUF) for a path. Further, since the height and critical frequency of the ionosphere depend on the time of day and the level of solar activity, with the aid of foF2 maps of the globe for different times and levels of solar activity, it should be possible to predict radio propagation off in the future, for the same months, at similar times of day and in other solar cycles. Two such maps are shown in Figures 3 and 4, the first one showing the state of the ionosphere at solar minimum in 1976 and the second one at the following solar maximum in 1979.

Those two maps were representative for conditions at the spring equinox, a time when the earth is illuminated symmetrically with respect to the equator and the sunlit region extends from 0 to 180 East geographic longitude. The fact that significant ionization extends beyond the sunlit region is due to the slow rate of electron loss at F-region altitudes, on the order of 300 km. In addition, the lack of symmetry of the map with respect to the geographical equator is due to the geomagnetic control of electrons in the ionosphere. Thus, a better or more symmetrical organization of foF2 maps would be found using geomagnetic rather that geographic latitudes. However, for practical communications purposes, the foF2 maps are given in more convenient geographical coordinates.

Before WW-II, vertical soundings of the ionosphere were taken at only a small number of stations. But with the start of hostilities in WW-II, such observations were expanded greatly so as to provide reliable radio communications on a world-wide scale. By the 1950's, maps such as shown in Figures 3 and 4 were readily available. But beyond those steps, the "reach" of propagation predictions was extended by Newbern Smith in the USA and independently by K. W. Tremellen in the U.K. Their approach was to consider paths longer than one hop and apply the critical frequency idea at each end of a path. Thus, a tentative MUF was worked out for the first hop on a path and then again for the last hop.

Experience seemed to show that a path would fail most often at one end or the other so paths with two or more hops were considered to be open for oblique propagation at a frequency below the lower of the MUFs for hops at the two ends. That scheme is called the "control-point method" and continues in use today although if one were pressed for a more reliable estimate of an over-all MUF, MUFs of any intermediate hops would have to be considered as well and the MUF for the entire path taken as the lowest one for all the hops.

MODERN DEVELOPMENTS

The global maps for foF2 are but one example of the wealth of information that had been collected and organized as a result of the expansion of ionospheric sounding after WW-II. With that database available, the American Central Radio Propagation Laboratory published ionospheric maps on a regular basis and made them available to parties interested in making their own predictions of HF radio propagation. In a historical sense, those maps represent the culminating documentation of the photo-chemical era of ionospheric study.

But there were disruptions of that well-ordered scheme, intrusions which are now recognized as relevant to the new era where plasmas and fields dominate the discussion of the ionosphere. One example, found J. H. Dellinger in 1937, was that some solar flares cause radio black-outs from the effects of bursts of solar X-rays penetrating to the D-region of the sunlit hemisphere. Other disturbances studied in that era had similar origins: the bombardment of the ionosphere by electrons from aurora or protons from some energetic solar flares. Finally, scientists in the late 1930s began to note that there were cases of ionospheric disturbances associated with magnetic storms.

In a sense, the understanding of the origin of those effects on radio propagation awaited the developments in theory and experiment which came well after WW-II. In the photo-chemical era, the cases of particle bombardment at auroral and polar latitudes were discussed in terms of the particles being guided in their motions by the geomagnetic field, then viewed as a symmetrical dipole. In essence, the particles were agents, guided by magnetic field, which "mapped" downward other disturbances in regions at much greater heights. While those events were of interest in their own right, the study of their distant origins and mapping along field lines ushered in a new era, now dealing with the coupling between the plasma in the ionosphere and the distant magnetosphere, and even the interplanetary magnetic field.

PLASMAS AND FIELDS

The figure of speech, "action-at-a-distance", may not seem appropriate to characterize the origin of the basic ionosphere, solar photons liberating ionospheric electrons after going across the open region between the sun and the earth, but there is some truth to it. But the coupling between the ionosphere and the magnetosphere is different, involving the continuous interaction between plasma (protons and electrons) and fields, both electric and magnetic, across that same vast expanse. And that is the case even though it begins back at the sun where field strengths are large and ionization complete and ends in the ionosphere where the earth's magnetic field is weak and the ionization of its atmosphere only slight.

The physics of the new plasma and fields ionospheric era is purely classical, the combination of Maxwell's Electromagnetism and Newton's Mechanics, and is termed "magneto-hydrodynamics" in some circumstances and plasma physics in others. While ionospheric effects appear simple when mapped down to low altitudes, only involving small numbers of particles or ions in the ionosphere, the problems are complex in formulation and geometry. To see the latter, just look at Figure 5 which shows the earth and its magnetosphere, as understood at the present time.

This figure gives a snapshot of the field line topology, the earth's magnetic field compressed by the solar wind on the dayside and drawn out on the nightside. Historically, the geomagnetic field had been thought to be like that of a dipole. But with observations of the solar wind by spacecraft, the dipole model gave way to one where the geomagnetic field is confined to a cavity carved out of the stream of interplanetary plasma going by, something like the wake behind an object fixed in a stream.

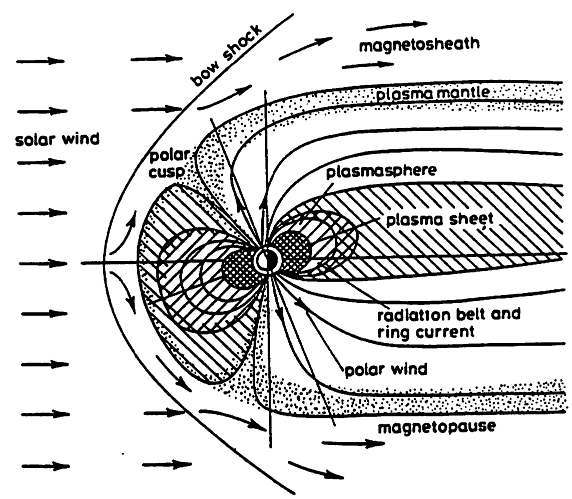

Figure 5 - The earth's magnetosphere (From Davies 1990)

The first observations which suggested this new configuration of the earth's magnetic field came early in the Space Age, a Pioneer spacecraft going out from earth carrying nothing more sophisticated than a rotating search coil. The magnetic field in close to the earth in the sunward direction was orderly, decreasing as expected with a dipole model. However, out around 8-10 earth radii distance from the geocenter, the field started to fluctuate in magnitude and direction, suggesting a disordered magnetic regime. After that, the field became more orderly again, when the spacecraft passed into the region of the interplanetary field.

What is now termed the magnetotail has something of a similar history but involved spacecraft in highly elliptical orbits, crossing the region behind the earth time after time. From those two sets of satellite observations, the present model finally emerged: a turbulent region behind the bow shock formed by the solar wind and an extensive magneto-tail behind the earth. Without getting into processes in the magneto-tail, at least for the moment, Figure 5 shows the geomagnetic cavity carved out of the solar wind has two field-line configurations. The first is a low-latitude toroidal arrangement of dipole-like field lines and the second a high-latitude arrangement where field-lines rise from the polar regions and extend into the geomagnetic tail on the nightside of the earth. These two field-line geometries have the effect of dividing the terrestrial ionosphere into three regions, one mapped by low-latitude field lines, the other mapped by field lines and plasma processes in the magnetotail and a transition region between the two regimes on the front of the magnetosphere, denoted as the polar cusp, where solar plasma may enter directly into the ionosphere.

The early development of ionospheric physics took place when the dipole model was still considered the correct description of the geomagnetic field. While not appreciated at the time, two of the major ionospheric disturbances known then find their understanding in the present field model. Thus, polar black-outs were known before WW-II but it was not until the International Geophysical Year (IGY) of 1957 that the geographical extent and character of those black-outs was established.

The principal instrument responsible for untangling the black-out problem was the riometer (Relative Ionospheric Opacity METER). It is a radio receiver which monitors galactic radio noise around 30 MHz. Thus, its record shows the signal strength of the radio galaxy as it passes overhead. With any radiation bombardment of the atmosphere that penetrates to the D- or E-regions, increased ionospheric absorption occurs and the galactic radio noise reaching ground level is reduced.

Those polar black-outs, now known as polar cap absorption (PCA) events, follow some solar flares and result from energetic protons accelerated at the flare site reaching the vicinity of the earth. The earth's magnetic field acts as a spectrometer, allowing only protons of a certain minimum momentum (or energy) to reach a point on the earth and deflecting all others away, back into space. The cut-off energy as a function of geomagnetic latitude could be calculated with the dipole model and suggested ionospheric absorption would be the greatest at the magnetic poles where the protons would simply slide down the vertical field lines.

The riometer network over the northern polar cap during the IGY showed otherwise, the ionospheric absorption showing little, if any, latitude variation during PCA events. After much intellectual anguish, it became apparent that the dipole model had to be abandoned. But what to take its place? It took some time to find the present model.

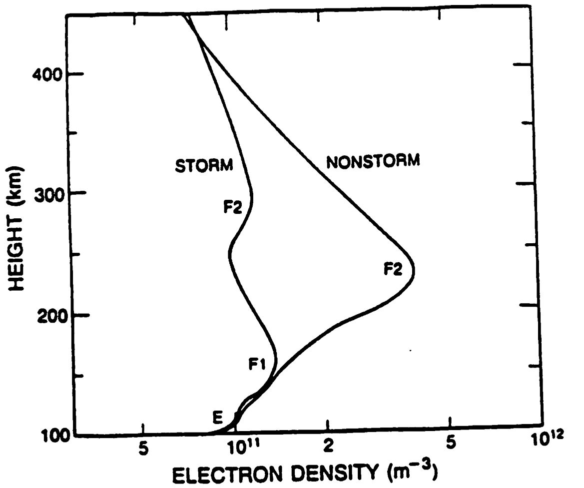

Figure 6 - Electron density profiles for quiet and storm conditions (From Davies, 1990)

The auroral displays in the optical part of the spectrum and auroral ionospheric absorption (AA events) in the radio spectrum resulting from such activity also had some clues within them. In particular, with the equatorward expansion of auroral displays at the onset of magnetic storms, it was found that any polar cap absorption in effect at the time expanded in area also. In terms of the field topology shown in Figure 5, those effects would be understood if more non-dipole field lines were in the geographic polar caps and auroral activity located on field-lines just below the transition between dipole and geotail field-lines.

The physics of the magnetosphere is difficult and often defies one's intuition. Thus, the explanations of polar cap expansion and auroral activity involve the concept of "field-line merging". For polar cap expansion, the physics of the problem indicates that solar wind plasma coming up to the earth carries magnetic field-lines with it and on encountering the front of the magnetosphere, the interplanetary field lines may actually "merge" with terrestrial field lines if the interplanetary field has a significant southward component. On that basis, dipole-like field lines would "merge" with inteplanetary field lines and then be carried back into the magneto-tail as the solar wind continues to advance, thus enlarging the polar cap.

Other merging or "reconnection" processes are invoked back in the magnetotail and result in some field lines moving in toward the front of the magnetosphere. Those same processes are considered to energize low-energy electrons in the magnetotail, sending them earthward and giving rise to auroral displays. Of course, all this takes place in three dimensions, not just the two dimensions in Figure 5, and the result is a convective motion of field lines and associated plasma, from both the solar wind and the magnetotail directions.

There are other disturbances in the F-region during geomagnetic storms and in contrast with PCA and AA events, they reach into regions of lower latitudes as well as a wide range of longitudes, lowering the critical frequency foF2 there. While the effects of storms on foF2 are complicated, varying with local time, season and latitude, their study was carried out using data organized according to geomagnetic latitude of the observing site and the time after the sudden commencements of magnetic storms.

Those studies showed that major magnetic storms could reduce foF2 at sub-auroral latitudes by as much as 30% and reach 5-10% reductions at mid-latitudes in the day after the onset of a storm. In a qualitative sense, the latitude variation of foF2 reduction can be understood in terms of processes being initiated on field lines as solar plasma compresses the magnetosphere, ionospheric effects being greatest on higher latitude field lines which map closer to the front of the magnetosphere. And by the same token, the fact that a wide range of longitudes are affected means that convective processes are involved as well.

An excellent example of the storm depression of foF2 is shown in Figure 6, an electron density profile over St. John, Newfoundland in April 1965 from the records of ground-based and satellite-borne ionosondes. The loss of ionization at the F2-peak and the presence of a lower F1-peak in ionization resulted in a reduction in critical frequency and a shortening of hop lengths across Newfoundland during the disturbance.

Of the three forms of ionospheric disturbance, solar proton or auroral electron bombardment and ionospheric storms from magnetic disturbances, the latter ties together theories and understandings developed during the earlier photo-chemical era and with the more modern ones developed during the current era involving "plasmas and fields". Thus, the present view is that the undisturbed ionosphere is really confined within the low-latitude, dipole-like field line regime seen in Figure 5. If viewed from above one of the poles, the ionospheric plasma contained in the toroid would extend out to about 6 earth-radii, corresponding to a geomagnetic latitude limit of 65 degrees.

The ionosphere in that region is created close to the earth by solar UV but photo-chemical processes determine the ionic composition and distribution in altitude. At low altitudes, the atmosphere is well mixed and the positive ions are mainly those of nitrogen and oxygen molecules. Around E-region altitudes, the photo-dissociation of oxygen becomes important and the principal ion in the F-region is that of atomic oxygen. But at those altitudes, collisions are infrequent and the gases are no longer well mixed; instead, they are sorted out by mass in the gravitation field, the lighter ones extending further out from the earth. That affects the ionic composition as the lightest atmospheric constituent, atomic hydrogen, undergoes charge exchange with atomic oxygen ions, thus creating the high ionosphere populated with electrons and protons.

The electrons and protons are constrained to gyrate around the magnetic field lines, sometimes likened to loops or rings held on a metal wire. The ionized gas or plasma will flow upward along the magnetic lines of force until the plasma gas pressure is equalized along the entire line of force, extending from the northern to the southern hemisphere. The ionosphere as we know it is located at the feet of the magnetic field lines while the region containing plasma at greater altitudes is called the plasmasphere. The outer limit of the plasmasphere is called the plasmapause and plasma densities fall by one or two orders of magnitude in the 2-4 earth-radii between the plasmapasuse and the magnetopause, the limit of ordered geomagnetic field lines.

So much for the description of the undisturbed ionosphere. Now, when it comes to disturbances, in this model they are to be understood to result from field line merging advancing inward to around the plasmapause, even further inward if the pressure of the solar wind is great enough. With merging, the electrons and protons are no longer held on field lines which are closed or connected with the conjugate hemisphere. Instead, the particles will diffuse outward and be lost for ionospheric processes as they gyrate on field lines which are now "open", going back toward the magnetotail and then connected to the interplanetary field.

Ionospheric disturbances during magnetic storms involve decreases in MUFs on paths and are always greatest at the higher latitudes. In that regard, the penetration of field line merging provides a natural explanation of the events, ionospheric electrons on the feet of field lines essentially released to the interplanetary medium instead of being held on closed field lines. And when the pressure from the solar wind subsides, the original dipole-like field lines will then become connected again and the plasmasphere will be refilled by photo-chemical processes at ionospheric heights. Of course, refilling takes place as the earth rotates and at a rate which depends on solar activity, taking days to bring the ionosphere back to its pre-storm condition.

CURRENT ISSUES

While a smooth, slowly-changing ionosphere describes the basic understanding of propagation during the photo-chemical era, studies in that era also dealt with disturbed regions which tended to be large and with long time-scales. Such large events will continue to be of interest on into the future. Even in the photo-chemical era there were indications of roles played by smaller regions and on shorter time-scales. This interest was generated by radio scientists noticing flutter effects in propagation at auroral and equatorial latitudes.

At auroral latitudes, the suggestion was obvious, indeed "eye-catching", with auroral displays showing a wide range of activity through their motions and intensity variations. With the knowledge that energetic electrons were coming down field lines, ionizing atoms and molecules as well as exciting visible emissions, it took no stretch of anyone's imagination to conclude that irregular patches of ionization might exist with those same spatial and temporal scales.

The rapid auroral flutter of voice signals on paths going through auroral displays confirmed the matter. Those events are part of what is termed an "auroral sub-storm" and have their origin in field-line merging many earth radii back in the magnetotail, in the direction away from the sun.

Particle precipitation, like that at auroral latitudes, is not found at equatorial latitudes yet radio signals traversing those regions show "flutter", i.e., deep and rapid interference fading, particularly in the evening hours and at the equinoxes. In that regard, there are two important equatorial effects: an equatorial anomaly of the ionosphere, with higher than normal heights and critical frequencies, and an equatorial electrojet of current at E-region altitudes.

The equatorial electrojet, recognized and understood before WW-II, is the more important of the two effects as it is closely related to the source of the second. Thus, there are strong ionospheric currents driven by an east-west electric field or "dynamo" due to the interaction of tidal winds and charged particles, created by photo-ionization, with the local magnetic field. At equatorial latitudes the geomagnetic field has a small dip-angle with respect to the horizontal direction; in addition, the geomagnetic field is in the north-south direction. As a result, ionospheric electrical conductivity in the east-west direction reaches large values just north and south of the geomagnetic equator and strong currents of electrons and positive ions are driven by the dynamo.

The equatorial electrojet may show spatial irregularities as a result of a "two-stream instability", an effect in plasma physics due to the large relative velocity of the electron and ion streams. Those irregularities may give rise to a type of sporadic E-layer but the dynamo electric field driving the current system also results in an evening uplift of the F-region as ionization encounters the north-south magnetic field. This is the "fountain effect", producing a higher than normal F-region at low latitudes.

The flutter fading on equatorial paths points to the presence of irregularities at F-region altitudes and those irregularities, like the ones at auroral latitudes, tend to be magnetic-field aligned, now in the horizontal direction. The presence of spatial variations in the electron density means that scattering of radiation plays a larger role in propagation while that of wave refraction is diminished as a result of less "smoothness" in the medium. In those circumstances, waves may be scattered instead of refracted downward, carrying signals farther forward for longer periods of time and making critical frequencies (and MUFs) seem higher for trans-equatorial paths. Of course, that result is not exactly a new idea as the "operational MUF" for high-power (50 kw) transmitters is higher, due to effects from ionospheric scatter, than the classical MUF derived from refraction.

Higher power, shorter wavelengths and ionospheric scattering are the directions ionospheric research has taken recently, the idea being to penetrate the F-region peak and explore top-side ionospheric structures directly from earth using the back-scatter processes. In the 1960's, satellite-borne ionosondes, such as the Alouette series from Canada, were used to explore the top-side ionosphere but only with convential sweep-frequency techniques because of power limitations. That study proved particularly valuable in obtaining the complete electron density distribution of the ionosphere shown in Figure 1. As might be expected, however, it did not reveal any gross structure of a photo-chemical origin such as found below the F2-layer.

Alouette did show top-side irregularities, ionograms with so-called "Spread-F" characteristics; but satellites, in their ever-changing motions, broaden the scope of some ionospheric studies and frustrate others for lack of continuous coverage. At present, the approach has shifted to using high-power radars at fixed locations (e.g., the American installation at Arecibo, P.R. at 30 degrees magnetic latitude and the EISCAT installations in northern Scandinavia) to explore the structure and motions of ionospheric plasma at and above the F-layer peak.

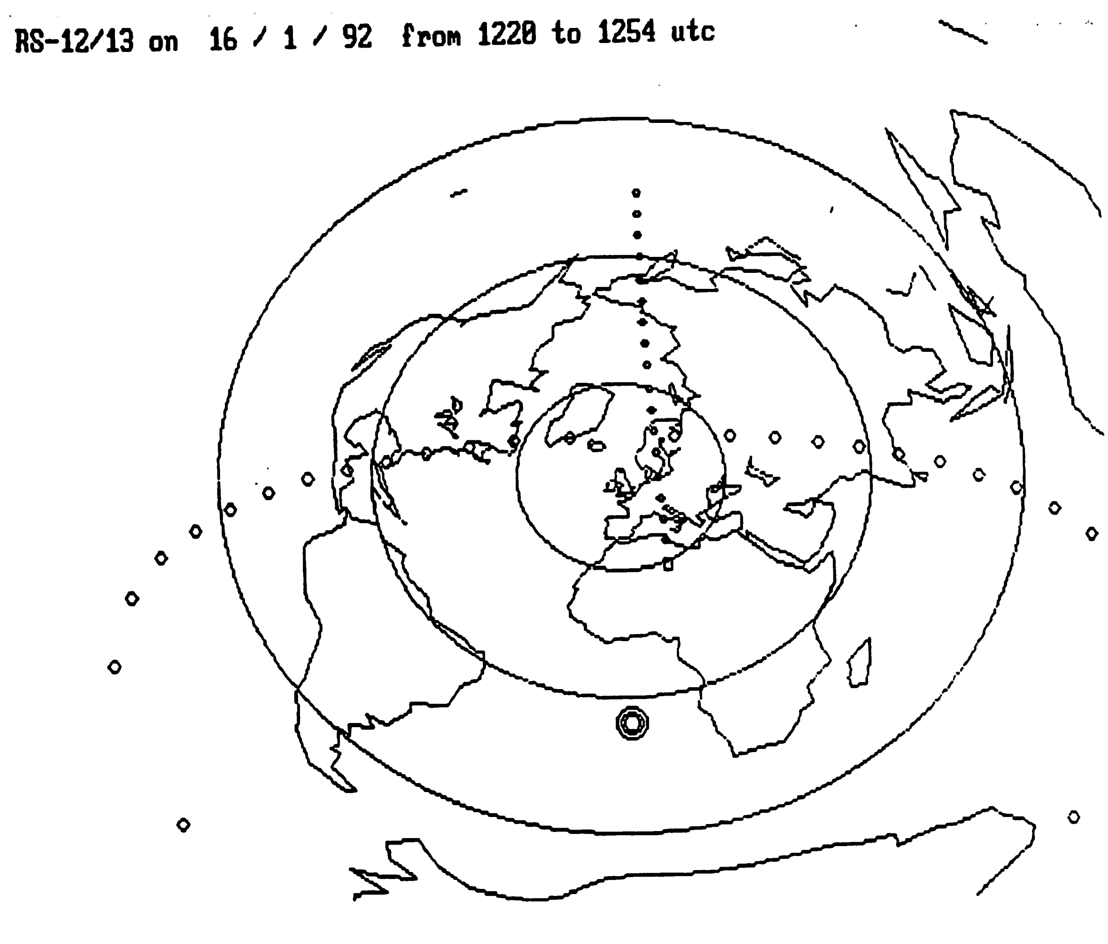

Figure 7 - RS-12 satellite track for January 1992 (From Branegan and Brown, 1993)

One problem of considerable interest is the mid-latitude trough of the F-region, a region of low electron density lying between 50 and 70 degrees magnetic latitude which occurs between dusk and dawn. It was discovered in the recordings of the Alouette satellite and shows a steep gradient in electron density at the F-layer peak. Like the lower boundary of the auroral zone, it is quite variable in location during active periods and the ionospheric tilts from its steep gradients in electron density may produce off-great-circle propagation, a matter of continuing interest and speculation.

From the experimental standpoint, the spatial and temporal resolutions of ground-based sounding programs have been insufficient to show the trough among the features of the quiet ionosphere but its presence does not stand in doubt. At present, theoretical discussion of the mid-latitude trough deals with the convection of ionospheric plasma across the polar cap, driven by processes in more distant regions of the magnetosphere, and possible changes in electron-ion recombination rates which would lower the electron density.

Other ionospheric processes at high-latitudes involve plasma convection from the dayside, showing correlations with the N-S direction of the interplanetary magnetic field (IMF) at the front of the magnetosphere. Thus, the polar F-region has been found to be either characterized by sunward-aligned auroral arcs during quiet conditions when the IMF has a northward component or large patches of enhanced plasma density in anti-sunward motion during active conditions when the field points more southward. Of particular interest is the fact that electron density enhancements up to a factor of ten above quiet conditions have been noted, bringing F-region critical frequencies in the polar cap up from a low level around 2-4 MHz to occasional levels as high at 9-11 MHz.

Those observations were obtained by looking vertically upward with ionosondes in the two polar caps and using IMF data from various satellite observations. Interestingly enough, enhanced patches of ionization have a propagation aspect as well, enabling 29.4 MHz beacon signals from the Russian satellite RS-12 at 1,000 km altitude to be propagated across darkened polar caps for great distances.

The first indication of such unusual propagation came from here in the Northwest when the 29 MHz beacon signals of RS-12 were heard coming over a dark, winter polar cap from just north of Mongolia. This went on over a two-week period, some nine events noted around local noon. A quick check of IONCAP predictions showed the path should not be open at those times, even though the 29 MHz signals came down from 1,000 km altitude and were reflected off the ground some 3,000 km ahead of the satellite. In short, the best model of the polar ionosphere was being violated and a different explanation required for the observations.

An independent verification of those observations was obtained from Scotland where the station logs of GM4 showed no less than twelve cases of similar, distant signals from the RS-12 beacon coming across the polar cap dur the same two-week period. And the same local noon feature was observed in Scotland.

It was suggested that the signals represented propagation via drifting patches of F-region ionization and corroboration might be obtained by contacting the US research group conducting ionosonde studies near the geomagnetic north pole. An inquiry was made as to whether their observations showed enhanced patches of ionization during the period in question and the reply confirmed the presence of enhanced F-region ionization as well as foF2 values favorable to oblique propagation by means of them.

An excellent example of these events is shown in Figure 7. On that occasion, January 16,1992, the RS-12 pass was an ascending one and signals picked up in Scotland at 1220 UTC as it came across the southern horizon. The satellite passed over Scandinavia and the northern horizon around 1236 UTC but was last heard at 1252 when the sub-satellite point was just south of the Kamchatka Peninsula (40 N, 170 E). After reflection off the earth, the great-circle distance for that RF path amounted to about 6,000 km.

While those observations covered only a short period, further observations of RS-12 orbits by GM4IHJ in Scotland as well as by L. K. Andersen, a Danish SWL, have extended the coverage from November '92 to mid-March '93 and increased the number of days showing anomalous propagatgion to 38 and with 18 days showing more than one such event.

CONCLUSION

The basic terrestrial ionosphere results from photo-ionization and photo-dissociation of the atmosphere by the solar spectrum. It is made more complicated by the presence of the geomagnetic field and shows temporal structure primarily due to particles, plasma and fields of solar origin reaching the outer boundary of the magnetosphere. While the photo-chemistry of the lower ionosphere and wave propagation at medium and high frequencies are still of interest for communication purposes, in recent years there has been a major shift of priorities and resources in the research community with the result that interest in ionospheric processes now centers at high latitudes and altitudes around the F-region peak.

How those studies are conducted depends on which hemisphere is involved. Thus, in the southern hemisphere, where the population density is low and inhabited land masses more removed from the polar regions, the current emphasis is on expanding coverage by establishing a number of automated observatories at remote sites in Antarctica. Of course, due to power limitations, observations at remote sites are restricted to passive recordings, e.g., overhead ionospheric absorption, magnetic variations and pulsations, etc.

The northern hemisphere, where the population is greater and located closer to the polar regions, offers better logistics so more active programs are pursued and the future will see a continuation of ionosonde observations in the polar cap as well as more radar probing of the topside of the ionosphere. Those programs, however, look upward and not off to the horizon, as with propagation studies. But the prospects for the latter are excellent, particularly in connection with studying the presence of ionization patches in the polar F-region, as found recently from monitoring the RS-12 satellite.

For the useful life of the RS-10 and RS-12 satellites, 29 MHz beacons will be available for studying propagation. Suitable observing sites are another matter as the most favorable locations would be at northern geographic latitudes of 50 degrees or higher. From there, it is possible to look into the polar caps and receive beacon signals returned by ionospheric refraction from ionized patches, even after a ground reflection deeper in the polar cap.

Future possibilities for monitoring those HF satellites are quite promising as there are many sites with permanent population along the coast of northern Russia, Alaska and the Canadian Arctic. With a growing awareness of the interest in the problem, additional satellite recordings of signals from polar patches by amateur operators and SWLs would supplement the vertical ionospheric observations at fixed sites in the Arctic.

Another possibility would be the monitoring of ground-based beacon transmitters. Already, there are a number of 28 MHz beacons operating but they are limited to northern Scandinavia and the U.K. If a number of additional beacons could be established around the Arctic coast, it would be possible to monitor the beacons continuously on trans-polar paths instead of just a limited number of satellite passes each day. That arrangement would provide not only continuous coverage but also show the growth and decay of polar F-region patches by observing signal propagation on individual paths as well as those which intersect in the polar cap.

All of the above amount to an agenda for the next solar cycle, starting in 1996. An "Arctic Initiative" by amateurs and SWLs is an exciting idea to consider. Perhaps it is something that could be nourished and developed even as we go toward solar minimum. Certainly, it would be something at the leading edge of studies in propagation.

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TROPICAL BAND PROPAGATION FROM ASIA

The Long and the Short of It

David Clark and Tony Ward, VE3NO

Editor's Note:

The following is the third major article published in Proceedings dedicated to unraveling some of the mysteries of Tropical Band propagation. The first two of these were co-authored by David Clark and John Bryant (*Proceedings 1990* and *Proceedings 1991*).

For this edition, we have asked Tony Ward, VE3NO, to join David in this continuation of the series. Tony is a native of New Zealand and brings Southern Hemisphere DXing experience to bear on our discussions. Further, as a world class Low Band amateur radio DXer and contester, Tony's "two-way" experience adds some insights into this complex subject that are otherwise difficult for the SWBC DXing fraternity to access.

INTRODUCTION AND REVIEW

We have chosen to build on the thoughts advanced in earlier *Proceedings* by Bryant and Clark, beginning with their 1990 "Notes on Tropical Band Propagation" (Bryant and Clark, 1990) and their "Additional Notes on Tropical Band Propagation" (Bryant and Clark, 1991a), as well as their follow-up series on "Tropical Band Dawn and Dusk Enhancements" that appeared in the pages of NASWA's *Journal*. (Bryant and Clark, 1991b) These articles were complemented by Bill Tippett's "Long Path and Skewed Path Propagation on the Lower Frequencies" which also appeared in *Proceedings 1991*. (Tippett, 1991)

As noted in the original *Proceedings* article, the major literature to that time comprised three volumes: *Ionospheric Radio Propagation*, published by the US Dept. of Commerce in 1962, *The Shortwave Propagation Handbook* (Jacobs and Cohen, 1979 and revised) and *Low-Band DXing*. (Devoldere, 1987) None of these are wholly satisfactory for today's needs. Devoldere's treatment of propagation was marginal to a broader purpose, and the other works focus more on strong signal "normal" modes of propagation of greater interest to professionals than the weak ephemeral signals that are the building blocks of the Tropical Band DXers' interest. Thus the 1990 benchmark study saw a move away from the traditional modes of propagation favoured by broadcasting engineers, and a heightened interest in less mainstream theory --- such as Blanarovich's "conduction" concept put forth as early as 1980. (Blanarovich, 1980)

A worthy addition to the major literature came after the release the aforementioned 1990/1991 articles. This was *The Ionosphere: Communications, Surveillance, and Direction Finding* by Leo F. McNamara, who for some years was associated with the Australian Government IPS Radio and Space Services. (McNamara, 1991) This very readable and profusely illustrated work was a useful reference to us in the preparation of this article. Very recently, McNamara has released a follow-up text, *Radio Amateurs' Guide to the Ionosphere.* Although we have not yet obtained a copy, the book was the subject of a highly favorable review by Bob Brown in the August, 1994 issue of *Worldradio* magazine. (Brown, 1994) We understand that the content of the first nine chapters is virtually unchanged from the 1991 text but a new chapter dealing with the use of propagation prediction programs has been added.

Finally, we should mention Bob Brown's own *Long-Path Propagation: A Study of Long-Path Propagation in Solar Cycle 22.* (Brown, 1992) While Bob's exhaustive, yearlong analysis of openings from the West Coast was based on his two-way contacts on 20 meter CW, it provides a frame of reference for comparison and contrast with longpath openings of interest to us on the Tropical Bands.

The traditional models of propagation are covered in the major literature cited above and in volumes from the ARRL and RSGB, so readers are referred to these sources for the terminology and theory. We will concentrate on those topics to which we feel we can make a new contribution, with a respectful if sometimes cursory nod to previous work.

Tony brings to the discussion an even more fully developed skepticism about the traditional multi-hop propagation model --- particularly as it applies to the low-bands --- than did Bryant and Clark in 1990. Further advances in understanding await the development of a bigger data bank of reception norms. Amateur radio operators have known for years that midwinter late afternoon 20 and 40 meter openings were on the longpath, and that this switched to the shortpath soon after dusk. The wider adoption of terminated directional antennas by SWBC DXers over the last ten years has permitted a closer look at this phenomenon on the Tropical Bands. The single most pressing need for further improvement in the understanding presented here is probably clear data on the vertical angle of signal launch and arrival at our receivers. The engineering literature remains concerned primarily with short and intermediate haul high and medium angle modes primarily. We comment briefly here but also refer you to Tony's stand-alone antenna article elsewhere in this edition of *Proceedings*.

As recounted by Bryant and Clark in the 1990 and 1991 articles, the acceptance of the importance of experiments by Appleton and other early researchers put in place the conventional multi-hop model of long-distance propagation that remained unchallenged for many years. This model, we suggest, may successfully account for little beyond the intermediate distances on HF. In fact by 1977 it was recognized by many broadcast professionals that the multi-hop model was seriously flawed as it applied to trans-global paths --- between Germany and Australia initially. (Hortenbach and Rogler, 1979) This also lead in 1978 to the adoption by the ITU/CCIR of a second model that has come to enjoy various names, such as "chordal hop" or "whispering gallery" for example. (ITU/CCIR, 1978) This brought the mechanism of twilight ionospheric tilt into play, and we will further develop some of those ideas here. Bryant and Clark also pointed out that beyond 6250 miles from the transmitter signals should actually *increase* as a consequence of ray convergence as the antipodal point is approached. We will take this work on spherical ray convergence to its ultimate manifestation --- specifically commenting on "antipodal focus" as it is far more readily observed from New Zealand than from North America.

Bryant and Clark also established a taxonomy of four major reception situations defined on the basis of sunrise (SR) and sunset (SS) at the receiver and transmitter that involve twilight at one end of the path only. These "partial darkness" paths were cited in addition to the conventional Grayline condition, with twilight along the entire path. We remain comfortable with this division and also with the more restricted definition of grayline adopted in 1990 too. The actual *causes* of these different modes are complex and compound but the scheme above remains useful, and we shall continue to use it as a framework in this article. While paths enjoying full darkness at both ends undoubtedly exist, they are of so little importance to the long-haul low-band DXer that we are paying little attention to them here. Again, this topic is dealt with in the 1990 and 1991 treatments. We have continued the emphasis on seasonality and the importance of twilight at either or both path ends, further codifying and refining the concepts.

As we move away from the feeling that we can quickly understand the propagation mechanics between transmitter and receiver for DX signals, the simple taxonomy remains attractive for two main reasons: 1) it works --- i.e. it is simple, comprehensible, and comprehensive, and 2) it doesn't paint us into any corners when we try to refine understanding of the modes of propagation involved. These are *not* simple and in many cases we now believe them to be of compound nature.

To illustrate our findings we have endeavored to refer, where appropriate, to the experiences of DXers living elsewhere in North America. David also has some feel for the West Coast situation based on his several DXpeditions with John Bryant, Nick Hall-Patch and Guy Atkins. Still, we must rely primarily on our more extensive experience in DXing Tropical Band Asians from Eastern North America (ECNA). Tony's "Down Under" experiences add the point of view of someone who has spent many hours at the dials near the other end of the path.

For all the attempts to provide mathematically satisfying modelling for ionospheric behavior, in 1994 we believe it remains a rather black art. And this is particularly true for the signals that SWBC DXers, as distinct from SWLs, are interested in. From ECNA, Asian openings in particular are typically short and sweet, and the most exciting DX opportunities are often to be found when least expected by conventional wisdom.

OVERVIEW OF SOLAR TERRESTRIAL ASPECTS

In previous *Proceedings* articles on long distance Tropical Band radio propagation, the influences of the sun have been essentially ignored. This was because we and all other radio people are still largely baffled as to the direct cause and effect relationship between particularly good DX conditions and specific occurrences on the sun. This is reflected, for example, in the energetic debate professionals in the field of solar astrophysics are conducting on the relationships among solar flares, geomagnetic storms and ionospheric storms.

As Bob Brown, NM7M, discusses in his article in this edition of *Proceedings*, a whole second era of ionospheric study began with our ability to launch satellite-born instruments. The mysteries of the ionosphere and its interaction with radio waves, especially at Tropical Band frequencies, are very much continuing areas of study.

So for this third article in the 'Trop Prop' series, we considered it important to address certain of the most important solar terrestrial aspects which apparently do relate to our ability to hear (sometimes dramatically enhanced!) or not hear particular signals under varying propagation conditions. It is true that many of the cause and effect relationships are uncertain or unknown, even among professionals in the field. However, as serious hobbyists, we have come to recognize certain probability patterns which if nothing else, we hope will augment the knowledge and improve the DX results for ourselves and other Tropical Band enthusiasts.

In addition to the major literature, we refer readers to Gary Oler's *Understanding Solar Terrestrial Reports: Part I - Morphological Analysis of Phenomena* which we found to be a useful reference in the preparation of this section. (Oler, 1991) We have also been fortunate to bring to this article some of the most recent research in the field. Thanks to the good offices of Dr. J Hruska, Chief Forecaster at the Geomagnetic Lab at the Geophysics Division of the Geological Survey of Canada in Ottawa, David was able to receive the 3-volume set of *Proceedings* of the international Solar Terrestrial Predictions Workshop - IV which was held in Ottawa, Canada, on May 18-22, 1992. Specific references are cited in the text which follows.

THE SUNSPOT CYCLE

We begin with the longer term solar cycles. Almost everyone is familiar with the average 11 year solar cycle, a phenomenon whereby a "quiet" sun with minimal sunspot activity becomes increasingly "active" over a 3-4 year period until it reaches a maximum. Thereafter, a more gradual decline in sunspot activity occurs, over an average period of about 7 years, until the next minimum is reached. The present Cycle 22 is well-advanced in its declining phase towards a solar minimum which will mark the beginning of Cycle 23. This minimum is currently expected to be reached at about mid-1996. Superimposed on the 11 year pattern is a 22 year cycle in which the magnetic polarity of the solar poles reverses sign.

It is very difficult to determine exactly when the peaks and valleys of the sunspot cycle occur. It is tracked in two ways: first, based on a moving average of the observed sunspot numbers and secondly, by the monthly level of solar flux or so-called "radio noise" measured at earth in the 2800 MHz band. There is a close correlation between the sunspot number and the 2800 MHz solar flux. Thus a high flux level, which may briefly exceed 300 during sunspot maximum, indicates a high level of solar (sunspot) activity. Flux levels of about 70 or less typify little or no sunspot activity during the transition from one cycle to the next at solar minimum.

The fundamental importance of the solar cycle, as manifest in the level of sunspot activity, is that sunspots are the primary source of enhanced ultraviolet radiation. This EUV radiation is responsible for the atmospheric ionization which, in turn, makes possible the skywave propagation of HF signals. As a general rule, the greater the sunspot activity, the greater is the degree of ionization and thus the capacity to reflect/refract increasingly higher shortwave frequencies. During periods of high sunspot activity the Maximum Usable Frequency (MUF) for daylight paths often rises above 30 MHz, sometimes even into the 6 meter amateur band above 50 MHz.

In terms of absolute signal strength potential, however, there is a limit to the benefit of increased ionospheric ionization since absorption by the more densely ionized E and F2-layers also increases. The daytime F1 and F2-layers merge into a single F-layer during the hours of darkness. The effect of recombination beginning after sunset making for a weaker ionosphere on nighttime paths, of course, results in a decrease in MUF's. Nighttime MUF's occasionally drop down into the range of Tropical Band frequencies during winter nights near sunspot minima.

For the most part, the nighttime MUF will remain above Tropical Band frequencies. The fact that as the frequency in question drops further below the MUF, the rate of absorption increases inversely with the square of the frequency is, however, potentially very relevant to Tropical Band DXers. A combination of increased absorption and higher background atmospheric noise ultimately defines the Lowest Usable Frequency (LUF). Excluding the twilight periods, it would be rare for the nighttime LUF to be higher than Tropical Band frequencies. One might think that the level of absorption implied by the wide differential between the Tropical Band frequencies and the nighttime MUF (especially near sunspot maxima) would all but eliminate long distance signal paths at say 90 meters, as is often the implication using propagation prediction programs. Most Medium Wave DXers would concur that trans-Atlantic and trans-Pacific propagation is far better during sunspot minimum. At the Tropical Band frequencies of present interest, fortunately, this predicted very poor propagation near solar maximum is not borne out in actual practice. Our all-important twilight or partial darkness paths are of special note because the implied LUF is often above 5 MHz (especially during approaching sunset at the receiver) and yet the Asian paths --- both short and long --- certainly remain viable, even at sunspot maximum.

Independent of the solar cycle, there is also a seasonal aspect associated with the intensity of ionization of the F2-layer. For reasons which are not understood, as far as we know, a given level of solar flux results in a much greater density (i.e. ionization) of the F2 layer during the spring and fall equinoctial periods, implying higher MUF's. (Dunphy, 1993) This would suggest greater levels of absorption at the much lower Tropical Band frequencies. For the same level of solar flux, F2 layer density is appreciably less at the summer and winter solstices, thus implying lower MUF's at Tropical frequencies. This phenomenon may contribute to the conventional wisdom that HF openings (both shortpath and longpath) between the Northern and Southern Hemispheres peak during the equinoctial periods, when critical frequencies and ionospheric conditions are more consistent throughout the world.

But again, we have no basis for suggesting the higher equinoctial MUF's are in some way unfavorable to propagation down at Tropical Band frequencies. On the contrary, from ECNA for example, the equinoxes are considered "prime time" for morning shortpath openings, given relatively quiet geomagnetic conditions, to Australasia and Eastern Indonesia.

SUNSPOTS AND SOLAR FLARES

Enough about MUF's and LUF's relative to the long term solar cycle! Most of the time they're just not terribly relevant or meaningful to those of us concentrating on Tropical Band DX reception, whether from Asia or elsewhere. Of much greater import are the terrestrial effects on ionospheric propagation arising from solar phenomena during various periods of the solar cycle. Let's begin with sunspots themselves.

Sunspots as seen from Earth appear on the Photosphere which is the lowest of the three layers of the sun's atmosphere, and is the "surface" of the sun as viewed in visible light. Above the Photosphere is the Chromosphere, which is a pinkish-colored band, about 2000 km thick, that appears visually during solar eclipses, or otherwise may be photographed using a Hydrogen Alpha filter. In this region of the solar atmosphere the drastic drop in particle density allows magnetic energy to dominate the physical for the first time. Above the Chromosphere we reach the highest region of the solar atmosphere, the Corona. This is the white halo seen extending many solar diameters away from the sun during solar eclipses. It has an extremely low density and is heated to extraordinarily high temperatures --- millions of degrees K --- by processes not yet understood, but which undoubtedly give it its strange properties. Certainly the heating is sufficient to raise the electron/ion plasma of the Corona above the solar-gravity escape velocity, and to produce a diffuse and variable stream of material that bathes the Solar System. This is the Solar Wind, and it has an average velocity of perhaps 400 km/s at earth distance and is responsible for the familiar dust tail of comets. Its low density and charged nature make it exquisitely susceptible to fluctuations in magnetic flux. While the Chromosphere may be the source of most flares, there is an important process originating in the Corona whereby relatively large masses of material are detached and expelled into space by spasms in the solar magnetic field.

Basically, most solar flares are short term explosions triggered by a sudden release of pent-up energy associated with the changing magnetic field of a complex sunspot region. Typical flare duration is from a few minutes to one-half hour although in extreme cases, flares may last upwards to several hours. The explosion spawning a major flare is truly immense. The most powerful, known as proton flares, have been estimated to release the energy equivalent of a 10 billion megaton bomb! Although the occurrence of flares is rather random, being directly associated with large sunspot groups they are essentially a phenomenon of periods associated with an active sun in the years approaching and during solar maximum.

Sunspots are regions of intense magnetic fields on the surface of the sun which actually originate deep within the solar mass. They rotate in the same direction and at approximately the same speed as the sun. About 27-28 days constitutes a full rotation near the solar equator and up to a week longer at the highest solar latitudes. Sunspots closer to the solar equator are more likely to have an effect on the Earth's environment when an associated solar flare erupts since these flares will more likely be pointed at the earth. Since the life-cycle of active sunspot regions may last for some weeks, the potential for recurrent effects becomes important to DXers.

Now we can examine the terrestrial effect of flares and in particular their relevance to Tropical Band DXers. Solar flares emit massive amounts of ultraviolet and X-ray radiation. The more powerful proton flares also emit copious amounts of energetic protons, as well as other particular material. Interplanetary shockwaves associated with flare emissions transport to the Earth as modulations of the Solar Wind. The intense radiation associated with a solar flare reaches the Earth at the speed of light --- about 8 minutes after the event. This "positive phase" causes a sudden increase in ionization, especially in the Equatorial Zone. While one might expect a resultant increase in MUF would adversely affect Tropical Band propagation of signals originating within or traversing the Equatorial Zone due to proportionately greater absorption at the lower frequencies, in fact the opposite seems to be the case. The reason for this situation is unknown.

High-energy protons associated with major flares are also often coupled to the Earth's atmosphere within a matter of hours by the sudden acceleration of the Solar Wind. Along the way they may seriously disrupt satellite communications, this being known as a satellite proton event. Since these protons carry their own magnetic (electrical) charge, they are influenced by intersection with the earth's magnetic field and are redirected towards the north and south geomagnetic poles. This gives rise to a Polar Cap Absorption Event (PCA) and a great increase in polar D-region ionization. Because of this enhanced absorption below the F-layer, trans-polar signal paths are likely to become unusable soon after the incidence of the flare. The dissipation of the flare-induced effects on the polar ionosphere may take several days and in the meantime, a significant geomagnetic storm may transpire.

THE MAGNETOSPHERE AND GEOMAGNETIC STORMS

As Bob Brown's article in this edition shows, the shape of the earth's magnetic field (i.e. the Magnetosphere) has been traditionally pictured like the spherical fields of a simple dipole magnet. The North and South geomagnetic poles are of opposite polarity and there is a vertical component exhibiting a "dip angle" in the lines of force. This angle increases to 90 degrees vertical at the magnetic poles. The lines of force connect over the equatorial region.

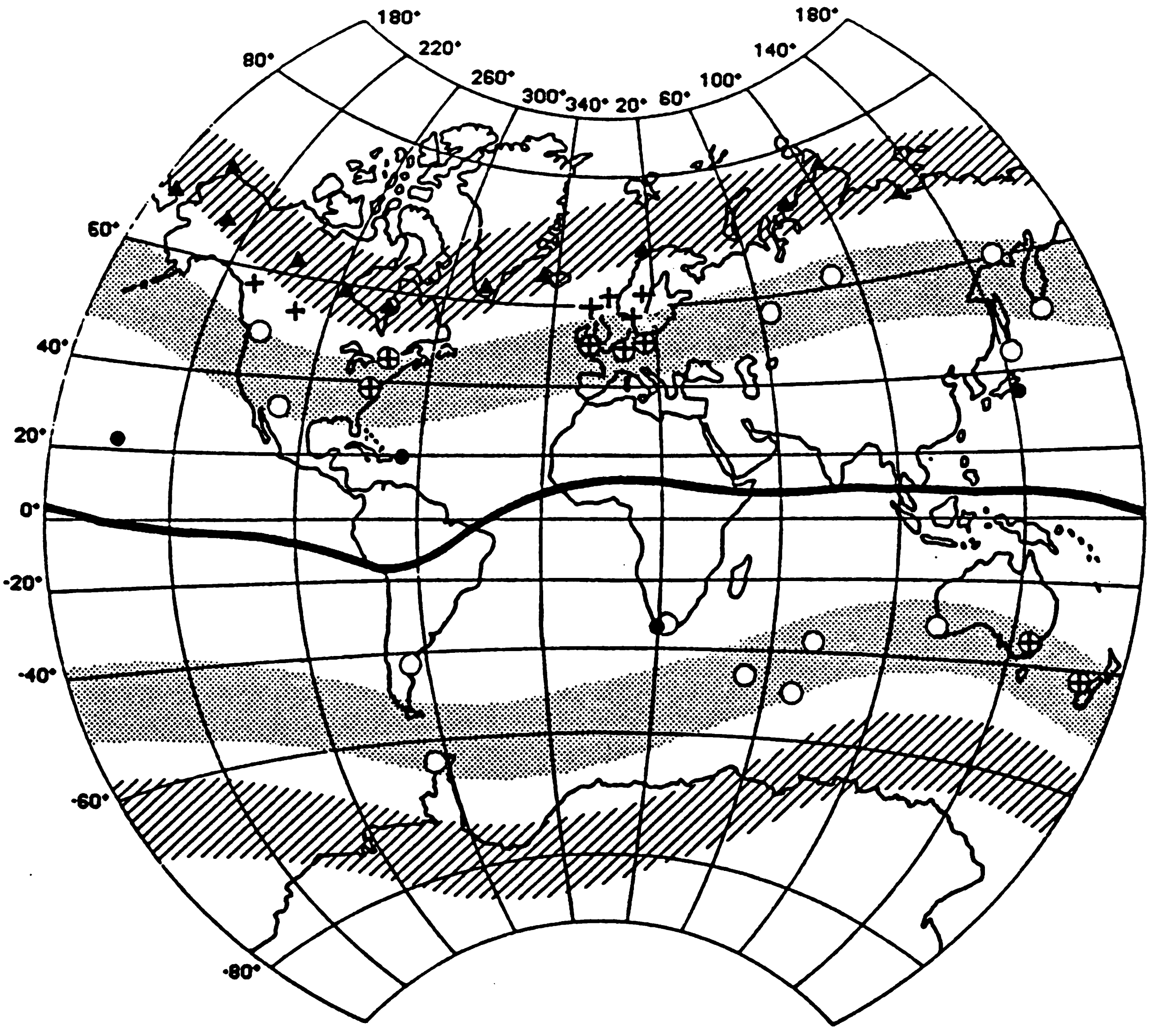

Figure 1: World Map Showing Position of Geomagnetic Equator and Average Extension of Auroral and Sub-Auroral Zones

As shown in Figure 1, the latitude of the geomagnetic (or dip) equator is variable relative to the geographic equator, in part because the magnetic poles are neither symmetrical nor constant in their position. This illustration also shows the average extension of the auroral and sub-auroral zones and the positions of stations belonging to various worldwide monitoring networks used in deriving geomagnetic indices. (Berthelier, 1992)

In reality, however, because of the persistent (though variable) pressure of the Solar Wind, the actual shape of the earth's geomagnetic field is similar to that of a comet. (Figure 2) The head of the "comet" facing the sun (and thus the Solar Wind) is called the bow shock region and it serves to protect us on earth from harmful X-ray radiation. The magnetic tail of the "comet" trails far behind the earth on the side opposite to the sun. When the speed and particle density of the Solar Wind is greatly amplified as the result of a solar flare, the shape of the geomagnetic field in the bow shock region becomes compressed. The enormously strong electrical currents thus induced in the earth's magnetosphere by this event cause a strong geomagnetic storm. (McNamara, 1991)

The geophysical effect of a solar flare is manifest normally about 36 hours after the incidence of the flare itself and thus is somewhat predictable in advance, although not all flares produce geomagnetic storms. As we shall discuss shortly, the ability to predict the potential for a geomagnetic disturbance is very important to Tropical Band DXers. As noted above, the average 27-day solar rotation is also an aspect that should be borne in mind. If a solar flare derives from a particularly active sunspot region during a given rotation when that region is facing the earth, there is a good possibility that recurrent flare effects could be experienced for at least one or sometimes several subsequent 27-day rotations.

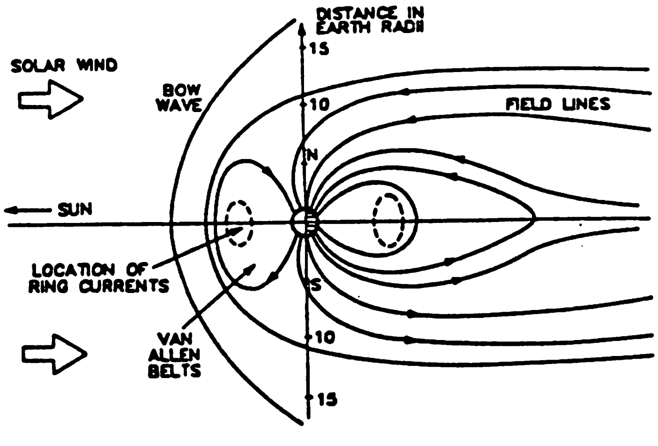

Figure 2: Simplified Diagram of Earth-Magnet in the Solar Wind seen from Equatorial Plane

If the interplanetary coupling between the magnetic fields of the sun and the earth is destined to cause a geomagnetic storm as a result of a solar flare, the sudden increase in the pressure of the Solar Wind intersecting the earth's magnetosphere will cause an increase in the horizontal component of the magnetic field. This is almost instantaneously detectable as a magnetic or "sudden" impulse. In addition, a fairly brief shortwave fadeout (SWF) on the daylight side of the earth is usually the precursor of a major storm. This is the initial phase of a "sudden commencement" geomagnetic storm as is typically associated with solar flares.

The main phase of a geomagnetic storm begins in earnest when the cloud of plasma particles released by the solar flare reaches the earth along a typically curved path likened to the trajectory of an uncoiling garden hose suddenly switched on. Arrival thus occurs sometime between 24 and 48 hours after the initial explosion. These clouds of solar particles, having their own magnetic fields, interact with the earth's magnetic field with an intensity that often results in a major geomagnetic disturbance. They initially saturate the Van Allen Belts and disrupt their associated "ring currents" whereby particles of opposite electrical charge carried by the Solar Wind flow in opposite directions around Earth at the equator. (refer again to Figure 2) Then the particle clouds are directed by the earth's magnetic lines of force toward the geomagnetic poles. As distinct from high-energy protons, these particles tend to congregate in and penetrate the ionosphere in the north and south auroral zones centered about 67 degrees geomagnetic latitude, within a zone between 60 and 75 geographic degrees N and S. The roughly oval-shaped auroral zones are where one finds the auroral electrojet of intense electric currents and these zones are associated with the strongest magnetic fluctuations anywhere in the world.

Plasma particles penetrating the ionosphere greatly increase the ionization of the E-layer in particular, often resulting in spectacular visible aurorae — Aurora Borealis in the northern hemisphere and Aurora Australis in the southern. This phenomenon also greatly increases signal absorption and the MUF of both the E and F-layers is reduced far below usual values. This set of occurrences is referred to as an Ionospheric Storm.

Refer again to Figure 1. This illustration shows the approximate position of both the auroral and sub-auroral zones when the geomagnetic field is quiet. While the auroral zones are first and most severely affected, very strong flares with massive particle emissions can cause them to expand outward into lower latitudes, thus affecting propagation from and into the mid-latitudes. Even visible aurorae may penetrate to quite low latitudes during the most severe, albeit rare, ionospheric storms.

It seems plausible that greatly reduced MUF's may in part account for unusually strong Tropical Band signals which DXers in North America and elsewhere experience on equatorial and trans-equatorial circuits during the early phases of such storms. Examples of this sort of enhanced propagation at the outset of a storm would be seen, for instance, along direct paths between North America and Southern Africa, South America, and from Asia via the long-path.

A PCA event and subsequent auroral activity, both deriving from the effects of a strong flare, may last for several days or more. However, the largely unexplained phenomena which result in temporarily and sometimes dramatically enhanced propagation of Tropical Band signals seem to be mainly confined to the initial positive phase and/or the transitional early stages of the main phase of the geomagnetic storm. Thereafter, signal degradation seems to take hold, probably due to increased absorption, especially in the E-layer. During the post-storm recovery phase, which may last for several days, Tropical Band openings are usually less than inspiring. If anything, the higher frequencies seem to recover faster.

For many years, solar astrophysicists have generally acknowledged that the vast majority of flares do not produce geomagnetic or ionospheric storms. However, at least some of the most severe geomagnetic storms have been recorded in association with very powerful proton flares during periods of high solar activity. DXers who have had the good fortune to be listening near the advent of such events have experienced some spectacular reception, especially on the Tropical Bands. That experience seems indisputable. However, very recent research based on monitoring of solar terrestrial events by the Japanese Yohkoh satellite discounts the importance of solar flares as the direct cause of geomagnetic storms. Reporting to a December 1993 meeting of the American Geophysical Union, Jack Gosling, of the Los Alamos National Obervatory, asserts that Coronal Mass Ejections (CME's), which are sometimes followed by flares, are the real culprit. Like flares, CME's are caused by violent shifting of the sun's magnetic field but emanate from the Corona, not

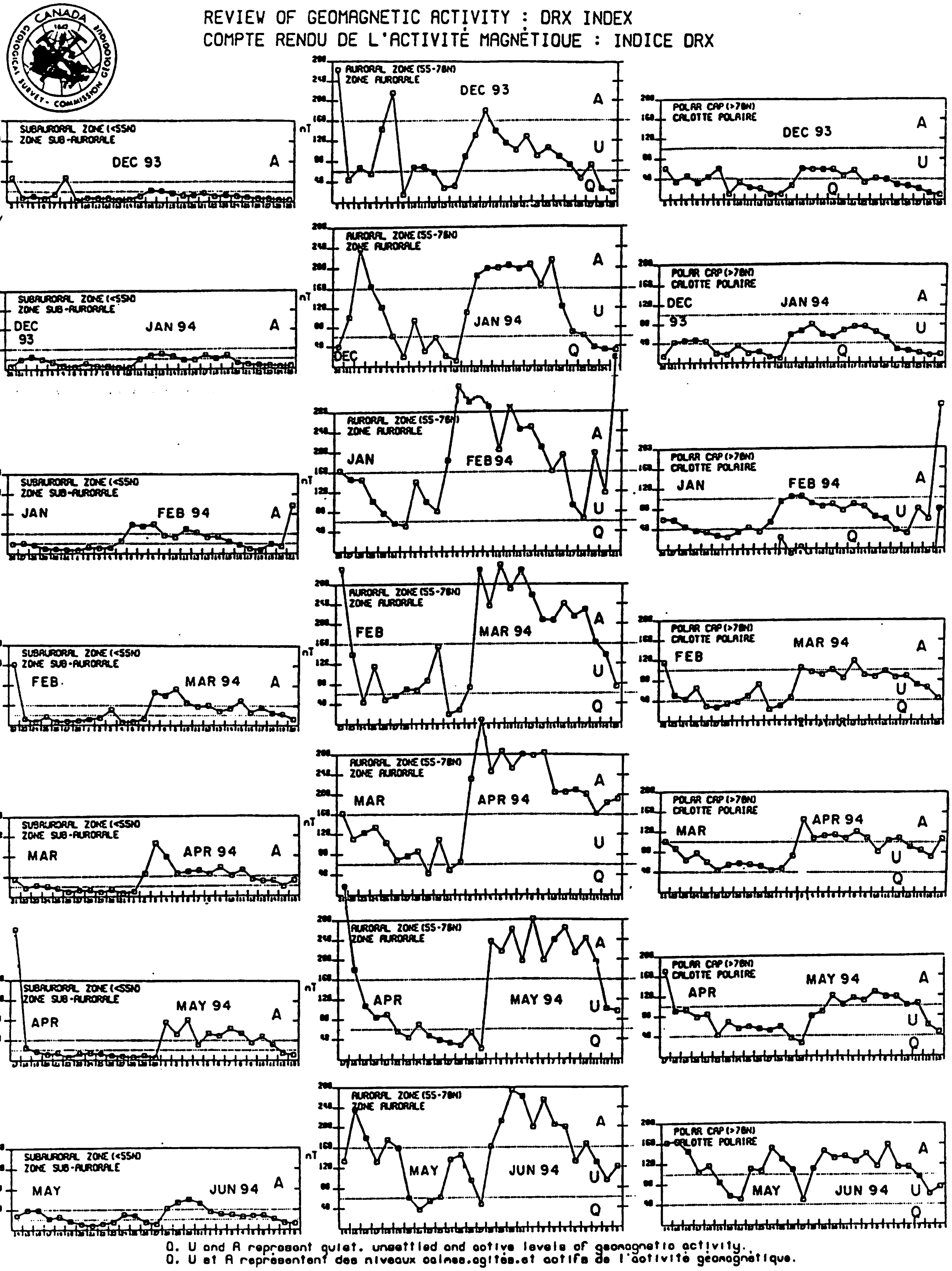

FIGURE 3: REVIEW OF GEOMAGNETIC ACTIVITY (DRX INDEX): DECEMBER. 1993 TO JUNE. 1994

the Photosphere with which sunspots are associated. Massive quantities of gas particles also join the interplanetary Solar Wind. In about one-third of the cases they generate a shock event followed by particle penetration in the auroral zones, similar to the terrestrial effects that have been ascribed to major flares. Like flares, the incidence of CME's is more pronounced during solar maxima. During the peak of the present Cycle 22, Gosling attributes all but one of the 37 largest geomagnetic storms to shock waves driven by CME's. (*Sky & Telescope*, 1994)

We have examined solar flares from the perspective of their dependence on sunspots (their incidence peaking towards sunspot maximum) and generally described the characteristics of a geomagnetic disturbance. CME's are now being described as the more relevant and "distinctly different phenomena" but either way, their geophysical effects at Earth are similar. This is the important point because however incongruous it may seem, there is a rather predictable, beneficial temporary impact on Tropical Band propagation. But what of the years of solar minimum when solar flares by their very origin and nature are exceedingly rare and CME's are also few and far between?

THE SITUATION AT SOLAR MINIMUM

Geomagnetic activity during the years of solar minima was not well understood until the 1970's when satellite exploration of the sun yielded a much better knowledge of the solar atmosphere, in particular the Corona, described above, which is an important source of large amounts of both EUV and X-ray radiation. The Corona is punctuated by occasional areas of much lower radiation which are called coronal holes, and we turn attention now to these.

Space exploration by the Skylab satellite enabled scientists to learn that coronal holes are particular areas of the Corona where the magnetic field lines of the sun are "open" or extending into space instead of arching back towards the sun. Large quantities of charged particles are able to escape through these holes, following the magnetic field lines into space and eventually becoming part of the Solar Wind. Coronal holes tend to form near the sun's polar regions and expand or migrate towards the solar equator. It has also been established within the last five years that persistent, high speed solar wind streams "from large scale structures of the coronal field" (including coronal holes) are characteristic of the period around solar minima and contribute significantly to recurrent effects. (Simon and Legrand, 1992)

Upon reaching the earth's atmosphere, the high-speed particle streams carried by the Solar Wind may intersect the earth's orbital plane. This can cause increased geomagnetic activity, especially in the auroral zones, and result in geomagnetic storms. Such storms, deriving from coronal holes, are not generally characterized by an initial sudden magnetic impulse as with flares and CME's but rather they tend to begin gradually and are thus referred to as "gradual commencement" events.

So, in contrast to sunspot numbers and the more significant CME events, the incidence of coronal holes and other structures associated with the Corona is concentrated towards and at solar minimum when their life cycles may last over a number of solar rotations. As a result, recurrent geomagnetic disturbances are much more prevalent though usually less severe, than the sudden and randomly incident storms associated with solar flares or CME's.

Commencing in December, 1993 and continuing through the first half of 1994, shortwave listeners and SWBC DXers experienced a dramatic example of the recurrent influence of a favorably positioned coronal hole. At about 27-day intervals for seven consecutive solar rotations, significant long-duration disturbances plagued shortwave propagation on the higher frequencies. Each geomagnetic disturbance exhibited a very sharp initial peak, followed by up to two weeks of continuing active conditions. Figure 3 provides a graphical review of the magnetic activity during this period, as recorded in the sub-auroral, auroral, and polar cap regions by the Canadian Magnetic Observatory Network. This network is operated by the Geophysics Division of the Geological Survey of Canada based at Ottawa, Ontario. (J. Hruska, 1994) Tropical Band conditions tended to be erratic too, but trans-equatorial propagational enhancements were typically in evidence during the commencement phases of each storm.

Just as MUF's have been found to vary with the season, there is also a seasonal aspect to the incidence of geomagnetic disturbances. Statistically, the vast majority of geomagnetic disturbances deriving from both solar flares or CME's, and those caused by coronal hole effects, occur during the equinoxes. Comparatively minimal activity is found at the solstices.

DC: I have not personally analyzed this aspect relative to the solar cycle to draw any definitive conclusions. However, I can say that in my experience over the past ten years or so of actively DXing "afternoon Asians", the equinox shoulder months of October and February have been found to yield some of the best skewed, longpath openings to western Indonesia (notably Sumatra) at the onset of geomagnetic storms.

SUMMARY AND EXAMPLE

The lessons we can derive from an appreciation of the relationship between solar terrestrial events and Tropical Band DXing success are quite simple, even though precise understanding may elude us. The most dramatic enhancements are likely to be associated with major flares or Coronal Mass Ejections towards sunspot maximum but one must be in the right place at the right time to catch the initial positive phase and the transition immediately preceding the main stage of a major storm. Towards solar minimum, propagation enhancements associated with coronal holes and persistently greater Solar Wind velocity may be somewhat less dramatic but recurrent patterns are more predictable and one can plan ahead of time to be at the receiver in anticipation of just such a positive effect. Figure 4 summarizes the distribution of various manifestations of solar activity and their relationship to the incidence of forms of geomagnetic disturbances through the duration of a typical solar cycle. Notice that recurrent effects '1' are predominant at solar minimum 'm'. Fluctuating geomagnetic activity '2' is characterized by a broad head and shoulders pattern across the years of solar maximum 'M'. The less frequent and random intense short duration periods associated with sudden commencement shock events '3' exhibit a similar pattern, peaking near solar maximum. The lower portion of the graphic shows the average distribution of geomagnetically quiet days. (Simon and Legrand, 1992) Finally, we should recognize that, superimposed on the long term solar cycle, is the seasonal propensity for geomagnetic storms to occur most often during the spring and fall equinoctial periods and least often near the winter and summer solstices.

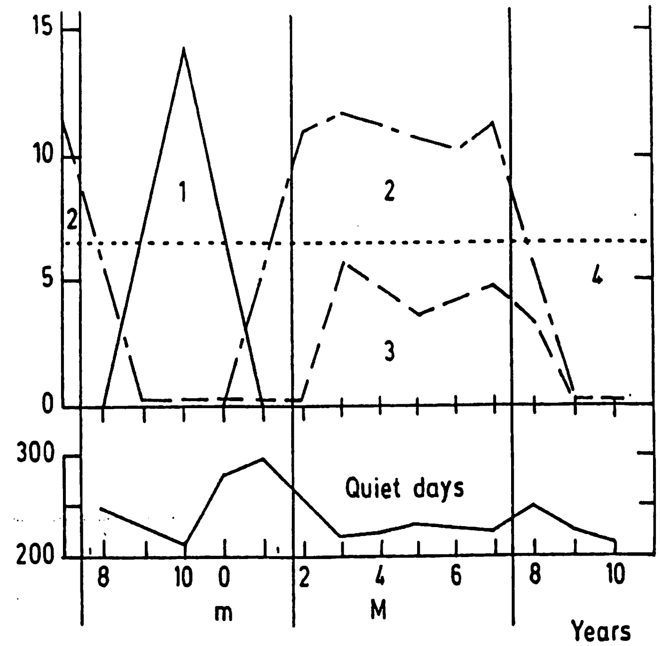

Figure 4: Average Distribution of the Components of Geomagnetic Activity during the Sunspot Cycle

As the following example illustrates, geomagnetic and ionospheric storms are often responsible for the temporarily enhanced propagation of long distance Tropical Band signals. This is sometimes along apparently direct (great circle) paths, but also frequently along skewed or bent Non Great Circle (NGC) short and long paths between Asia and North America. Longpath enhancements tend to be the most dramatic. This is at variance with the conventional wisdom which generally associates normal paths with multi-hop propagation along great circle bearings, usually short path, during periods of quiet (low A/K) conditions.

TRANSITIONAL ENHANCEMENT: THE JANUARY 11, 1994 EXAMPLE

For a few weeks centered on the winter solstice, a grayline path extends southeast from Ontario at a bearing of about 150 degrees (Figure 5), across the equatorial zone, passing through the South Atlantic Anomaly (sketched), then just tangent to the eastern extremity of Antarctica and up into Eastern Indonesia. The path is almost perfectly centered on Ujung Pandang in Sulawesi but the grayline zone extends as far east as Irian Jaya. The direct (great circle) longpath to Irian Jaya skirts just outside the southern auroral zone during quiet conditions and the path is usually optimum when the geomagnetic field has been settled for several days and the ionosphere is not 'depressed'.

As we discuss in a later section, Irian Jaya stations generally do not respond to a geomagnetic disturbance. In other words, they do not seem to propagate well, whether shortpath in the mornings or longpath in the afternoons. But we have known them to make a better than average showing during the initial positive phase and sometimes early into the transitional phase associated with the onset of a geomagnetic storm. By comparison, "classic" transitional longpath afternoon enhancements are associated with Southeast Asian signals originating further to the west, from whence their direct path would clearly intersect the southern auroral zone. The apparent skew of these longpath signals around the periphery of an expanding auroral zone then becomes obvious.

Logging afternoon extreme Eastern Indonesians (Irian Jaya/Maluku) during the short, mid-winter window, is no mean feat, even from ECNA. As contrasted with the powerful signals from Ujung Pandang, the implied grayline condition does not render especially good signals and when the hets do rise in sufficient strength to give up some audio, this may last for as little as five or ten minutes and rarely more than fifteen or twenty. Of course it must be recognized that a number of the relatively limited selection of target transmitters are of only 1 kW power or less. The interesting thing about the Irian Jayan peaks is that they occur 15-30 minutes *before* sunset at the receiver, and *at*, and up to fifteen minutes *after* sunrise at the transmitter. This pattern fits within a rule of thumb half-hour duration associated with the so-called "width" of the grayline at equatorial latitudes. Even so, since skywave absorption increases rapidly after sunrise, one might have expected the peak to occur slightly earlier --- towards the approach of transmitter sunrise, rather than immediately after. West of Ujung Pandang the midwinter pattern is in fact reversed. Signals peak 15-30 minutes *before* transmitter sunrise at which time it is already well past sunset at our receivers in Ontario.

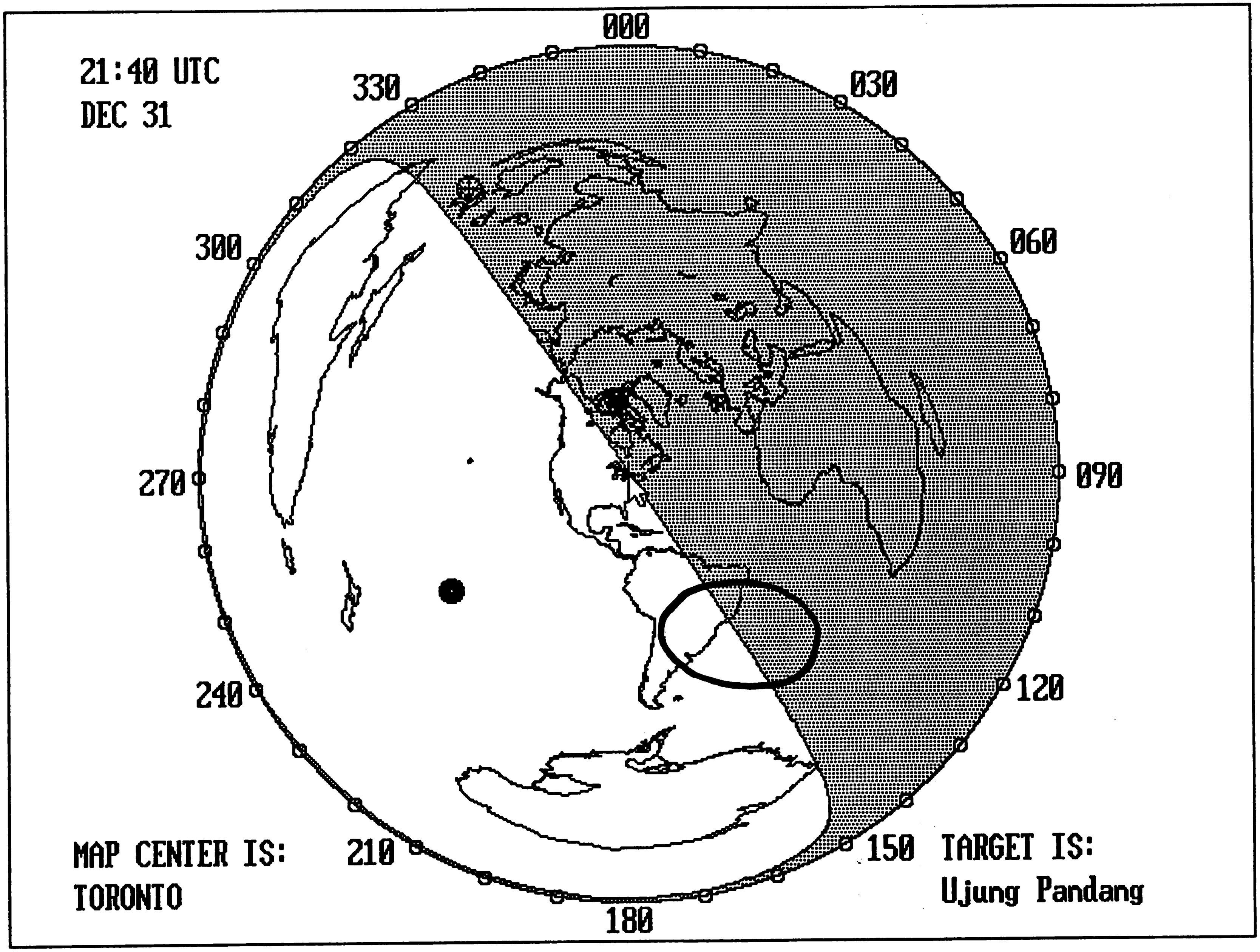

FIGURE 5: AZIMUTHAL-EQUIDISTANT MAP CENTERED ON TORONTO, ONTARIO, SHOWING POSITION OF GRAYLINE AT TORONTO 2140 UTC DEC 31 AND PATH TO DX TARGET AT UJUNG PANDANG. SULAWESI (MAP GENERATED BY DXAID V4)

Now that we've set the stage, we take you back to January 11, 1994. As it happened, both Tony and David were at the dials that midwinter afternoon. Their experience that day is quite notable. Eastern Indonesians were dramatically enhanced as might be expected to occur during the positive phase. Western Indonesians and other Southeast Asian signals were excellent too, as is typical of an enhanced longpath opening to Southeast Asia at the very onset of a geomagnetic disturbance which derived in this case from a large favorably positioned coronal hole.

TW: *This day I'm home at my suburban home near Toronto to take a look at the tropicals. At noon from school a quick check of WWV at 18 past the hour promised an ionospheric storm, and I'm anxious to see whether the promise will be fulfilled. It's a quarter to four --- 2045 UTC --- and two hours before local sunset the band is hopping with African signals on the Southeast long-wire I have selected. But I am after bigger game, and have the R8's memories preset to the elusive Irian stations. A fair challenge on the morning short-path are they, but I just know that under the right conditions I can get more than the faint carrier I have heard on the afternoon opening so far this season. The solstice is past, and time running out for this particular sport.*

It's early, but the whisper of a signal is there already on 4789.7 and an even fainter hint of Sorong on 4874.5. As the magic moment just before the hour approaches I concentrate on the stronger of the two and YES. The lilting refrain of "The Song of the Coconut Islands" fills my ears. Success! Perhaps merely by remoteness made exotic; Fak Fak! The tune resonates within me with the overlay of years of musical memories! The needle on the R8 hits S5, as the news from Djakarta fills my ears...but now I'm after the building signal of Sorong and down on 3385 Kupang promises to break through! Thirty minutes later they are in the log with the best audio I have ever got from them. What wonder how exciting the local news can be in a language I have no understanding of at all. But the lilting rhythm of the Malay tongue is unmistakable, and the village choir's voices leap around the globe in some strange way that I will try and fathom later. Right now it's keep the tape whirring and listen for the jumbled ID phrases. I follow the sun-up across the other side of the globe... Ujung Pandang (4753.3) is 20db over 9 an hour later...what a day for the books! The sun is 30 minutes gone below my horizon, and somewhere a giant hand pulls the great switch in the sky. UJ goes from local copy to a memory in minutes, but Kupang is a new one for me...and that will fade much more slowly from the mind...

DC: *Tony's experience that afternoon affords a hint of the DX-citement we associate with chasing winter long-path Asians on the Tropical Bands when geomagnetic conditions are turning from quiet to active or even disturbed. In this particular case, Tony must have broken away from the dials for an early supper, about the same time as I was tuning in at my rural property north of Toronto. Clearly I missed a superior Eastern Indonesian opening and those are pretty rare. But as he tuned out the fading Ujung Pandang a bit past 2200, I found that the Sumatrans and other nearby peninsular Southeast Asians were just coming up nicely! Let's check the records: yesterday, January 10, 1994, Planetary A index was a very quiet 04 but by 1800 this day of the 11th, the real-time K index had jumped up to a value of 5, indicating a sudden onset of disturbed conditions (refer again to Figure 3). Very interesting...and we are not surprised.*

MODES OF PROPAGATION

CONVENTIONAL:

The conventional model of multi-hop propagation of radio waves has been cited in our Introduction and Review and is dealt with by Bryant and Clark in their 1990 paper. That dawn signals often rise smoothly and magnificently to enhanced levels with their flutter and fading characteristics unaltered (except that the signal is stronger) argues most powerfully against multi-modal reception as the cause of the dawn peak. Yet most theories attempting to explain the phenomenon fall back on such approaches. Radio News in 1930 published an early version of ionospheric tilt as a cause, for example. The basic postulate of that article was that at dawn ionospheric tilt focussed the second and third hops at the receiver simultaneously, enhancing received signal levels. But this implies the existence of a sharp transitional phase with extreme fading, and this is not seen. Similarly a later theory saw multi-hop signals arriving simultaneously in a subtractive mode in which out-of-phase behavior produced weak signal levels. As the D-layer built up with the approach of day, higher angle skips would be lost first, leaving the lower-angle and stronger skips. These would be further enhanced by the subtractive effect. This theory fails on the same grounds as above.

Some variant on ionospheric tilting does seem however a likely candidate for at least some kinds of dawn/dusk enhancement. A major observation that is explained by both this approach, and that of Blanarovich (discussed below) is that while stations at each end of twilight paths experience the enhancement at dawn and dusk respectively stations at intermediate points along possible paths do not. Thus hams in New Zealand use sunset to talk to European stations experiencing near-dawn conditions on almost any of the HF bands, during almost any season. Tony relates a low-band tale that illustrates this mode in rather dramatic operation.

TW: *I well recall being the net in a three-way celestial ping-pong match involving the legendary Bob Tanner, ZL2BT. (Figure 6a, 6b) Bob was the first, and so far the only ham, to confirm two-way contact with 300 countries on 75 meters. He operated from Longburn, near Palmerston North, New Zealand, with a range of antennas over the years, but latterly a two element cubical quad with the top wire at about 135 feet on a home-built tower was his main sky-hook.*

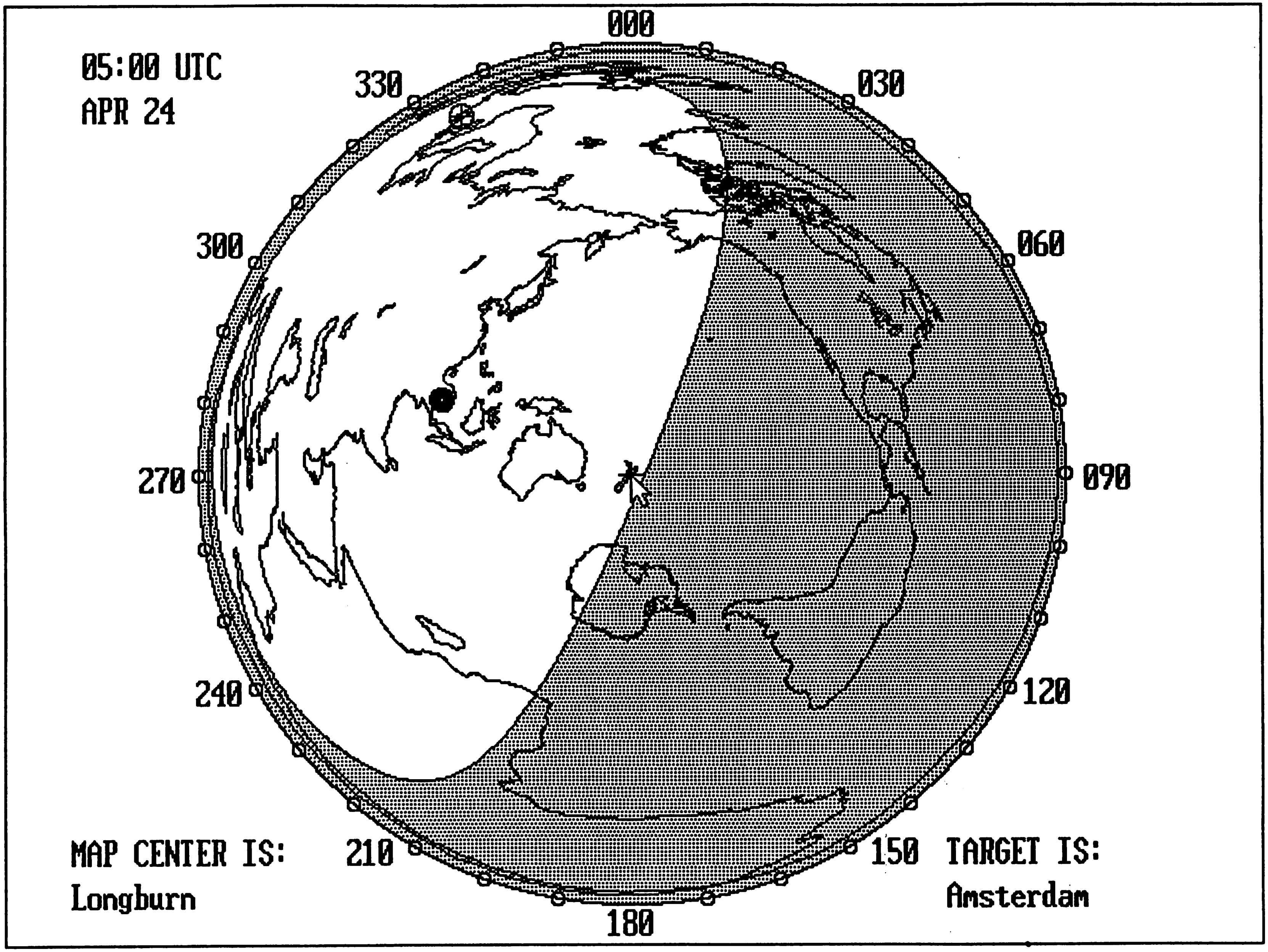

FIGURE 6A: AZIMUTHAL-EQUIDISTANT MAP CENTERED ON LONGBURN, NEW ZEALAND, SHOWING 0500 UTC APRIL 24 POSITION OF GRAYLINE AND PATH TO DX TARGET AT AMSTERDAM (MAP GENERATED USING DXAID V4)

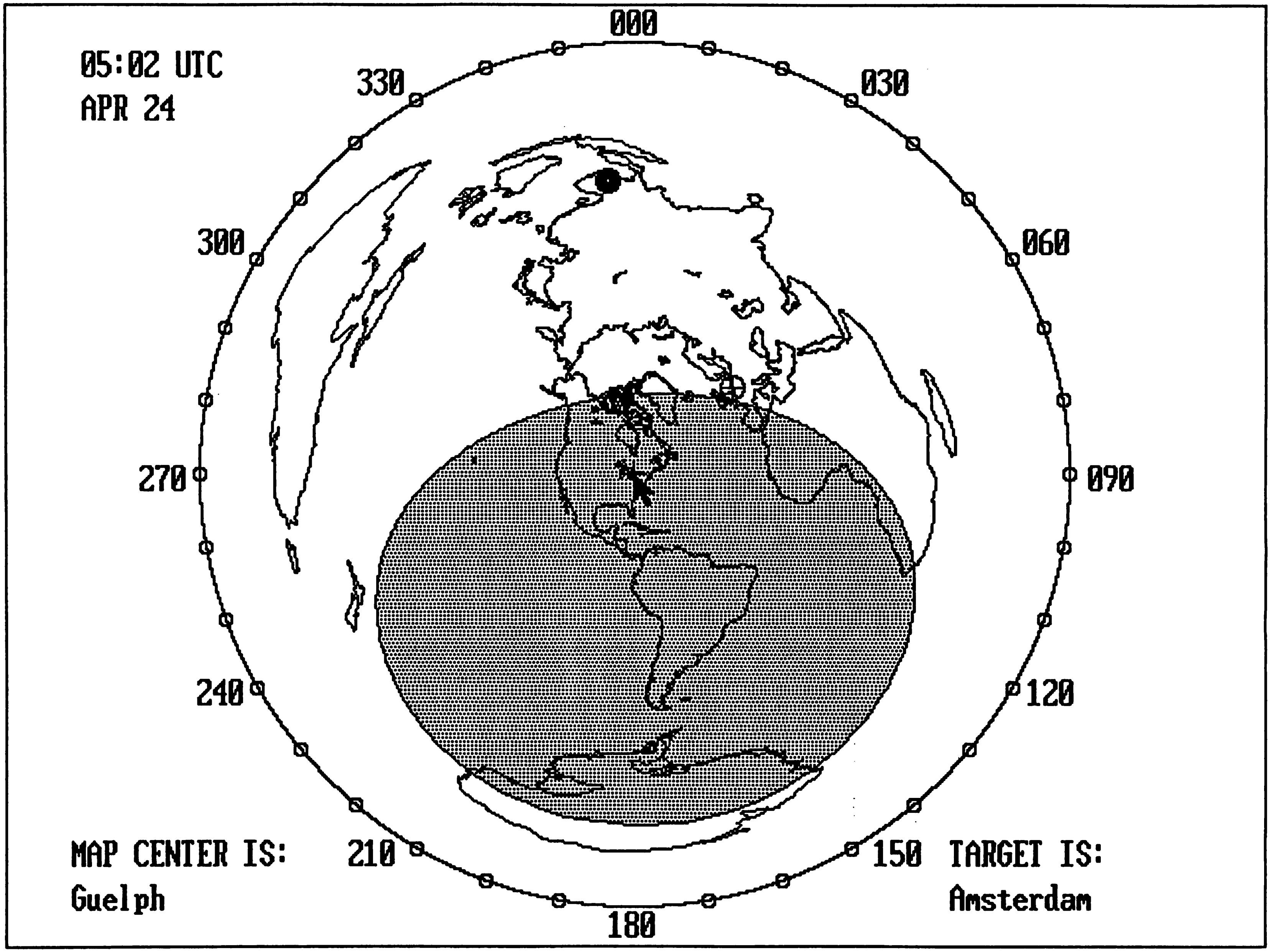

FIGURE 6B: AZIMUTHAL-EQUIDISTANT MAP CENTERED ON GUELPH, ONTARIO, SHOWING 0502 UTC APRIL 24 POSITION OF GRAYLINE AND PATH TO DX TARGET AT AMSTERDAM (MAP GENERATED USING DXAID V4)

Late one April evening, as local Ontario midnight approached, I engaged a Dutch station in voice conversation on 3795 kHz from my rural site near Guelph, Ontario. We had fairly good signal strength with each other --- about S9. Shortly after we started the conversation Bob joined in. He reported to Paul (in Holland) that he was hearing me at about S7. Paul and Bob were about S9+20dB with each other. I could hear not a whisper from Bob. As his sunset approached however he first appeared as a weak and watery signal, and then built steadily and rapidly to well over S9! This took a total of about 20 minutes. My signal report from Bob climbed from S7 to S9 + 20 dB in the same period. It is tempting to consider that Bob's signal initially passed right over my head skidding or ducting along the base of the ionosphere en route to Holland during the first 10 minutes of the strange three-way. As the influence of the steadily lowering D-layer at either end of the path made itself felt Bob and Paul were able to maintain contact easily using dusk/dawn high-angle enhancement. My low-angle radiating antenna --- a broad-side bidirectional delta loop at 100 feet --- provided good output, but was not able to intercept Bob's overhead signal until conditions changed to a more conventional path, a little later. At around this time, Paul's signal started to drop rapidly with Bob, as daylight advanced on him. At no time did ground stations in South America join the dialogue, confirming a phenomenon well known to both low-band hams, and to tropical band DXers. The signals were circling the globe at high elevation, unheard on the ground along the dark path, except for my participation, as discussed above. Operating from New Zealand myself on the low bands, I can recall remarkably few instances when simultaneous signals were received from both Europe and either of the Americas.

NON-CONVENTIONAL MODELS:

While the exact mechanism by which the signals pass from the dawn to the dusk end of the path is not yet known to us, speculation has centered on variants of chordal hop, or of a kind of whispering gallery mechanism. Yuri Blanorovich, VE3BMV, has offered another explanation in the previously referenced CQ magazine article and most accessible in Bryant & Clark's 1990 article.

As a super-active contest operator, Blanarovich has had ample opportunity to sample the behavior of the HF ionosphere under a wide range of conditions. He feels very strongly that we have been misled by the conventional diagrams of ionospheric height above the earth into accepting the traditional multi-hop mode. He favors a fibre-optic model in which "A majority of the radio waves are refracted and propagated --- conducted --- along the borders of media with different dialectric constants and are accompanied by scintillation." (Blanarovich, 1980) Scintillation is produced by the cloud-like nature of the propagating medium whose density and conductivity varies in time and space. It produces back and side-scatter and these effects show up in the watery nature of many received signals under suboptimal conditions. He relates improvement in higher frequency signal strengths during high sunspot number years to the higher average heights of the refracting/conducting medium. Longpath and grayline propagation are as easily explained with this model as shortpath. Radio amateurs have an obvious advantage over SWBC DXers in tackling the thorny problem of one-way propagation and here again, a conductive model provides a useful perspective. Light exiting a fibre-optic conductor scintillates and disperses in a fashion that is difficult to envisage in reverse. Daily here in Eastern North America --- particularly on 40 meters --- loud European signals can be heard each afternoon, but it is nearly impossible to get them to respond. No doubt this is why Kupang failed to hear my joyful shouts at finally receiving them on the afternoon longpath!

Bob Eldridge, VE7BS, became an enthusiastic supporter of Yuri's ducting concept and made some interesting follow-up observations, citing other supporting works. (Eldridge, 1989) He traces the introduction of the term *refraction* as a replacement for or adjunct to the use of the more traditional *reflection* in amateur radio and official publications, particularly post WWII. In fact the family of modes implied by use of the term chordal hop and others was well-established by 1959 when the CCIR published a report citing chordal hop, whispering gallery and ionospheric ducting (ITU/CCIR, 1959). This report in turn was founded on earlier referenced sources. All agreed that long distance single-hop transmission was possible without intermediate ground reflections. So in fact we are arguing over the exact mechanism rather than the phenomenon itself!

Hortenbach and Rogler of Deutsche Welle published the landmark chordal hop theory paper in 1979, although they in turn quoted earlier sources from the 1950's. (Hortenbach and Rogler, 1979) Waves launched at very low angles are guided by the lower boundary of the ionosphere (which acts as a single walled duct) rather than reflecting back to earth. Refer to Bryant and Clark's 1991 paper for illustrations. When dawn and dusk occur at ends of the path the tilts in the ionosphere resulting from its greater height in the dark hemisphere create the conditions necessary for initiating chordal-hop modes.

In addition, the concept of the "Sweet Spot" was first advanced by Bryant and Clark in 1990 and further developed in their 1991 article. The Sweet Spot can be characterized as a particular variety of "partial darkness" (receiver sunrise/ transmitter in post-SS darkness) propagation. The basic finding was that there was good evidence that Tropical Band signals from the Pacific and Asia tended to peak at North American dawn when it was approximately 9:00 PM local time at the transmitter. This pattern was tied by the authors to the phenomenon of spread-F, ionospheric irregularities which peak about mid-evening and are most predominate in equatorial latitudes. Further investigation published in their 1991

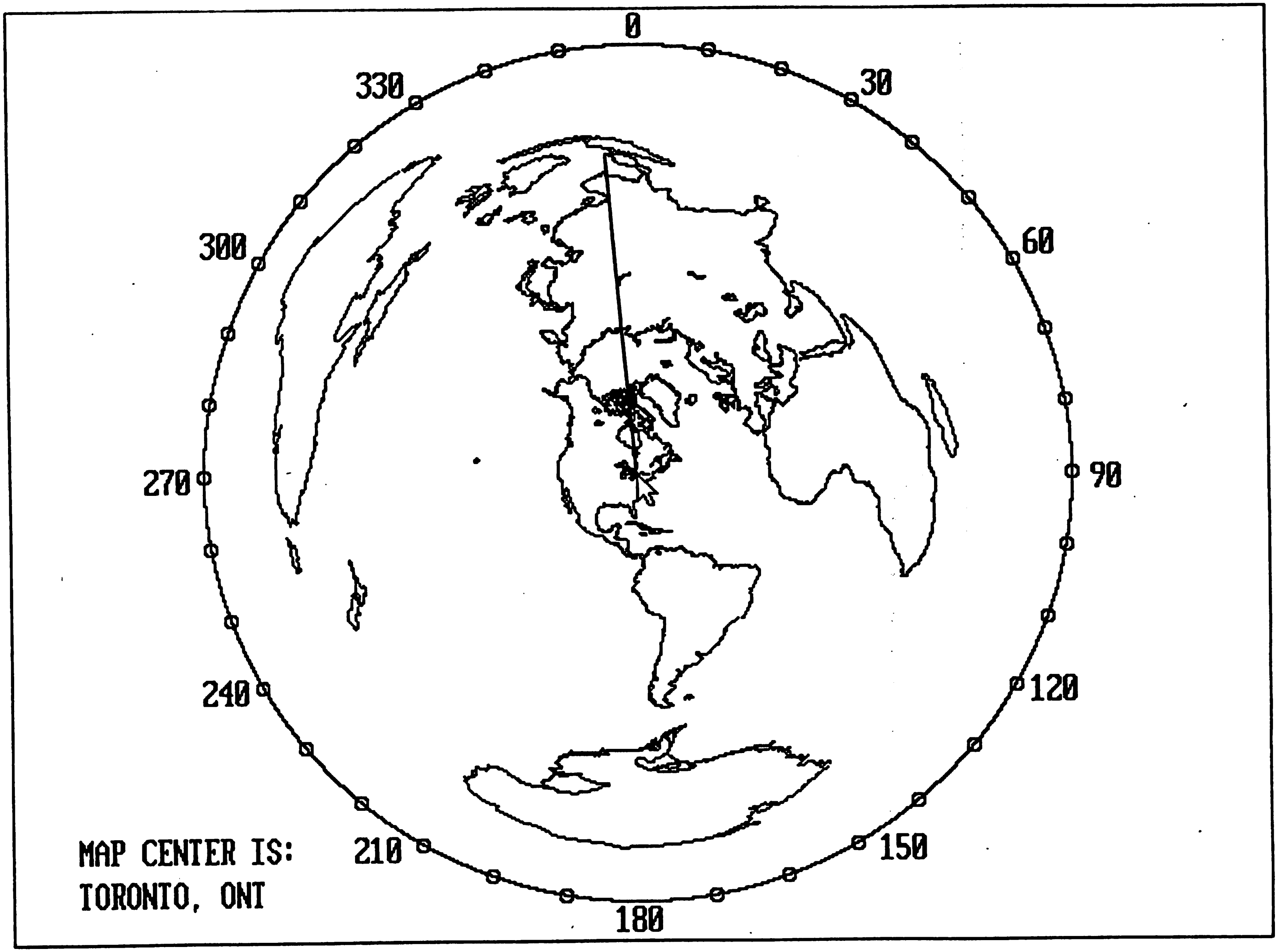

FIGURE 7: AZIMUTHAL-EQUIDISTANT MAP CENTERED ON TORONTO. ONTARIO (MAP GENERATED USING DXAID V2)

article indicated that under some circumstances, such as midwinter in the Northern Hemisphere, the peak could be closer to 8:00 PM. Since those findings were published, Bryant and Clark, as well as Guy Atkins, have all reported numerous occasions while DXing from the West Coast which confirm the consistency of this peak, even at different seasons. We have not attempted to advance the Sweet Spot concept further in this present work but continue to encourage DXers suitably located to review the literature, do their listening, and publish their observations.

GREAT CIRCLE AND NON GREAT CIRCLE SHORT PATHS

The "normal path" of an HF signal is conventionally understood to be the short great circle path between any transmitter and receiver pair. That path is clearly demonstrated on an azimuthal-equidistant map centered on the location of the receiver. (Figure 7) Be aware that the currently understood position of the North Geomagnetic Pole (NMP) is near 79 degrees N, 104 degrees W and the South Geomagnetic Pole (SMP) is near 66 degrees S, 139 degrees E. (National Geographic, 1992)

For Southeast Asia, if we consider the meridian position of Singapore as roughly dividing South Asia to the west and Australasia to the east, it can be seen that the implied "normal" path (sketched) to Southern Ontario (Toronto and vicinity where both David and Tony reside) is only about 5 degrees west of true North and just slightly east of the NMP. This means that the direct signal path is straight over the polar cap, intersecting the northern auroral ring at virtually a 90 degree angle, and crossing the entire disturbance zone situated between the latitudes of 60 and 75 degrees N on both the Asian and North American sides of the pole. Under quiet geomagnetic conditions, signals from Asian transmitter sites adjacent to Singapore and throughout much of Southeast Asia will also intersect the auroral ring on a short path to Eastern North America. But because we in Ontario are situated directly "under" the auroral oval, consider the much greater dispersion of Asian transmitter sites from which our reception would be affected when geomagnetic conditions are active or moderately disturbed.

On the shortpath for many of our favorite Asian DX targets, we would expect to signals to be best when geomagnetic conditions have been extremely quiet for an extended period and the auroral disturbance zone in its most contracted "normal" state. An azimuthal-equidistant map centered on Toronto implies that signals arriving from bearings between 330 degrees W and 30 degrees E could be expected to be subject to selective or flutter fading as a result of the scattering effect caused by transiting the auroral zone. Under active or disturbed conditions, this zone would widen a further 60 degrees or more.

It is indeed a nice simple picture this; quiet conditions and good reception over the shortest route. By contrast we expect disruption and increased signal absorption under geomagnetically stormy conditions. Reality turns out to be far more complex, and it is with morning reception of Southeast Asian Tropical Band signals that simple explanations start to fall apart. First: the signal breakup characteristic of paths on the higher shortwave frequencies (say 15 MHz) is simply not in evidence. Second: while quiet conditions often contribute to strong signal paths beyond the periphery of the quiet auroral zone (e.g.. PNG's and Eastern Indonesians at approximately 290 to 320 degrees W), signals from South and much of Southeast Asia, whose short great circle paths cross the northern auroral zone, are seldom at optimum levels during quiet conditions. More often than not, dawn signal enhancement occurs during the positive phase or during the transition period when the geomagnetic field is in the course of progressing from a quiet to a more active or disturbed state.

Finally, and of particular interest to us here, signals arriving at the receiver in such circumstances are usually apparently directed "around" the northern auroral zone along a Non Great Circle (NGC) route, trending northwest or even west, as "seen" on a directional antenna at the receiver. By definition the path is short, being less than 90 degrees removed from the true great circle bearing, but it is definitely seen to be "bent" or "skewed" to varying degrees off the great circle path. Bent or skewed paths from Asia to ECNA are a recurring theme throughout this article!

THE ECNA MORNING PATH FROM ASIA

The morning openings exhibit a tendency to migrate from East to West Asia and back again from autumn, through midwinter and into spring, in accordance with the seasonal migration and slope of the terminator. In some respects the converse occurs in the afternoon. Of course the N-S orientation of the dawn terminator mirrors that of the dusk terminator at the Autumnal and Vernal Equinox.

From Southern Ontario, morning signals from Singapore/Sumatra and toward the Indian Subcontinent are generally heard best on a NW beverage oriented at about 330 degrees, regardless of the position of the terminator. Strangely enough, Australasian signals that would be expected to be best on a more westerly beverage at 300 degrees are also usually strongest on the same NW antenna. During the 1991-92 and 1992-93 midwinter "Subcontinental seasons" it was observed that very often for the South Asian transmitter sites, signals were significantly superior on a Beverage pointed nearly west at 300 degrees. This is a NGC short path, rather far-removed from the NNE great circle path which was only occasionally viable under quiet conditions. This signal-bending effect was almost invariably noted when the A index was in upward transition from quiet to an unsettled to active state with an index in the range of 10-15, or sometimes higher. As we have already dwelt on at some length, "transition" is the key word. A condition whereby the short term K index was 0 or 1 at 0600 and up to 4 or even 5 by 1200 would almost invariably deliver --- for that one particular morning --- greatly enhanced reception, and on a path of arrival from the west, seemingly ducted well around the expanding auroral zone on the darkness side. The opening would generally last longer past "max dawn" than usual and signals exhibited none of the signatures of auroral flutter fading!

In the most recent 1993-94 season, however, the apparent arrival of the Subcontinental signals on a westerly bias was much less apparent than it was during the previous two seasons. Meanwhile, from the Midwest, John Bryant reported that the Indian signals were seldom heard at all on the shortpath. Most reception, such as it was, took place on his longpath antenna pointed SW. Indeed, there was a general consensus among Tropical Band DXers throughout North America that the 'Indian season' was without spark when compared with the prior two, especially on the 90 meter band. Perhaps all of this was related to differing MUF's associated with the rapid descent toward sunspot minimum but we really don't know. Certainly there were sufficient recurrent geomagnetic disturbances to have triggered the reception pattern we had learned by previous experience to associate with enhanced, skewed path morning reception from South Asia.

It seems possible that we (collectively) are not always using low-enough angle antennas. In other words, the Beverage antennas which had served us well may not have been as suitable for signals arriving at a different, possibly lower, angle in the most recent season. Tony erected his 'Carolina Beam' (refer to Guy Atkins' review article in this edition) in January of 1994 and noted reception of Indian stations well past local SR that were inaudible on his standard long-wires. This kept the Indian season going for him for several weeks longer than would have been the case otherwise as the terminator inexorably retreated back to the east, and eventually, even the superior low angle performance of the Carolina could do little to help.

GREAT CIRCLE AND NON GREAT CIRCLE LONG PATHS

During the primary fall, winter and early spring Tropical Band season, SWBC DXers -- especially those living in ECNA -- have come to better understand in recent years the possibilities for longpath reception from Southeast and South Asia during the late afternoon and early evening hours, and how this relates to the approach of sunrise on the Asian continent. Bill Tippett's previously cited article in *Proceedings 1991* was especially useful in opening up new vistas of understanding for many SWBC DXers. Tippett outlined the two most important Asian low-band longpath opportunities for us: the path from Southeast and South Asia in the late afternoon/early evening to Eastern North America, as well as the morning path from India and East Africa to Western North America. We would like to develop the discussion further here, with particular reference to our ECNA experience.

Enhanced openings are almost without exception associated with the transitional phase marking the onset of a significant geomagnetic disturbance. North American DXers living in the Eastern time zone and at more northerly latitudes, including the present authors, are especially well-positioned for the Southeast Asian long path.

One aspect of this that we have not yet seriously considered is our potentially favorable position in Southern Ontario relative to the 'Mid-Latitude Anomaly' discussed in Bob Brown's article. It may be that because we are situated in the sub-auroral zone and close to the steep ionospheric gradients marking the Mid-Latitude Anomaly, the apparently enhanced ducting of signals around the auroral zones is more pronounced at our 43 degree N latitude than at other locations further south, even within ECNA. The affect our position might have with respect to enhanced reception on the longpath, however, remains problematic.

While it seems plausible to associate increased geomagnetic activity with a skewing of signals around the northern or southern auroral zone, the spectacular signal strengths we sometimes experience on the afternoon longpath suggests there is an enhancement effect associated with passage across the 'Equatorial Anomaly' as well. Even the earlier literature envisages the possibility of an enhanced chordal mode (albeit in association with enhanced MUF) governed by the crests of high F-layer ionization fixed at about 15 degrees on both sides of the geomagnetic equator. It is interesting to note that the peak ionization occurs in the late afternoon (between 1700 and 1900 local time) and again in the evening (between 2000 and 2300 local time), at the equinoxes and at solar maximum. These trans-equatorial propagation (TEP) modes are known as afternoon-type and evening-type TEP respectively. We suspect that afternoon-type TEP may be an enhancement factor, even at much lower Tropical Band frequencies.

Yet-another aspect that intrigues us is that the longpath circuit from Southeast Asia apparently passes directly through the 'South Atlantic Anomaly' whose approximate position we have sketched in Figure 5. This is the zone where the contours of strength of the earth's geomagnetic field - expressed in terms of "electron gyrofrequency", are the lowest anywhere in the world. Purely in the realm of speculation, we suspect that this may, in some way, contribute to the late-afternoon signal enhancements we experience from Southeast Asia.

Whatever the confluence of circumstances, the reward is great, for typical signal strengths during a good opening from some transmitter locations are far stronger than during the traditional morning listening period.

THE ECNA AFTERNOON/EVENING PATH FROM ASIA

How does the afternoon/early evening signal path from Asia compare to the typical morning path and what are the hallmark geomagnetic circumstances? Simply stated, the typical path is not short, as for ECNA in the mornings, rather it is long path, although in most cases skewed to a greater or lesser degree from the implied great circle route. David will readily admit that he has virtually abandoned the premise advanced in Proceedings 1989 which associated short path openings during geomagnetic disturbances with enhanced propagation through the northern auroral "donut hole". (Clark, 1989) Still, rare afternoon shortpath openings continue to be observed near the equinoctial periods. But the long path is clearly dominant through the winter and, except for the most easterly paths outside the southern auroral zone, typically associated with the transitional onset of a geomagnetic disturbance.

The most westerly Indonesians (Sumatrans) begin to make an appearance by early September with the approach of the autumnal equinox and these same stations are the last to disappear after the vernal equinox in early April because of their much later sunset. Remember, the Indonesian archipelago extends some 3,000 miles and spans three time zones!

At midwinter solstice, however, the terminator is at its shallowest angle relative to both the equator and the geomagnetic equator. As we have mentioned already, this results in a near-grayline condition from Southern Ontario as far east as Irian Jaya. Unfortunately, sunrise at PNG stations is a little too early to enable even winter solstice longpath reception in ECNA. It should be noted (refer to Figure 5) that all of Antarctica is in daylight, and the terminator has reached its farthest extension away from the SMP, so absorption is at a seasonal minimum. Even so, as outlined in the preceding January 11, 1994 reception example, Irian Jaya signals are weak and usually audible only for a matter of minutes, peaking 15 to 30 minutes before our SS and at or just following SR at the transmitter. They are heard best on a southeast Beverage, although they may first appear from the East, more perpendicular to the terminator but then becoming basically parallel to the terminator on the southeast antenna at approximately 150 degrees. Openings are best during either quiet conditions or a positive phase enhancement just prior to a disturbance.

Then, through sunset, post-sunset dusk and progressively into the early evening darkness at our receivers, it is possible to receive stations strung across Central and Western Indonesia, coastal China, and the Indo-China peninsula, as the Asian sunrise terminator works its way westward towards the Subcontinent. Once the path shifts into Central Indonesia and points west, the great circle long path to ECNA now encroaches on the southern auroral zone and the Antarctic summer daylight. So, quite apart from the enhancement pattern associated with the onset of a geomagnetic disturbance, the apparent skew of the signals into a low loss twilight or darkness path around eastern Antarctica becomes pronounced. Afternoon wintertime reception is dominated by the trans-equatorial long path and is again generally heard best on a Southeast Beverage. At times the S-9+ signal strength of Ujung Pandang (presently on 4753.4 kHz) and certain Sumatran stations on both 60 and 90 meters (e.g.. Tanjung Karang-3395.1 kHz) can be outstanding given the right transitional conditions. The same holds true for quite a number of China-coast stations with CPBS2-4905 kHz the standout. Sometimes the onset of a major disturbance brings about 15 minutes of perfect armchair copy from the North Korean station on 2850 kHz. The better openings yield brief audio from rarer catches such as the only Taiwanese Tropical Band outlet, on 3335 kHz. To reiterate an earlier point, the ECNA midwinter reception peaks of Southeast Asians lying to the west of Ujung Pandang are quite at variance with the peak pattern cited above for Irian Jayans far-removed to the east. Now we find that signals peak 15 to 30 minutes prior to sunrise at the transmitter and this may correspond to 30 minutes or more past sunset at our receivers.

By way of comparison with our northerly latitude ECNA situation, DXers living in the Midwest or at more southerly latitudes in the Eastern time zone must await the trailing slope of the sunset terminator for the afternoon Asian path to open up. But for a short period at midwinter, the approach of sunset at the receiver coincides with sunrise at transmitters located in Sumatra. Somewhat limited reception is then possible, as John Bryant and others from the Midwest have reported in recent years. As far as we can tell, the onset of geomagnetic storming is still an appropriate precondition, albeit far less pronounced in its effects west of ECNA. At midwinter of the 1993-94 season, Guy Atkins, living in Seattle, recognized the advantage of favorable inclination of the approaching sunset terminator. He demonstrated that even on the West Coast it was possible to detect a signal from the western reaches of Sumatra (Medan 4765.8 kHz) at transmitter sunrise almost two hours before his local receiver sunset, as long as you were far enough north. While scratching out usable audio was a daunting task, there is no doubt about what Guy was hearing and this was truly a landmark accomplishment! Not surprisingly, Guy's several tentative logs coincided with superior openings here in Southern Ontario. If RRI Banda Aceh (3904.8 kHz) in extreme northwestern Sumatra ever returns to its traditional morning program period from 2300 s/on (inactive during the 1993-94 season), it would be another ideal target for the West Coast crowd.

After 2400 in the winter, nearly all of North America is in darkness as the sunrise terminator reaches the Indian Subcontinent. Then, in both Eastern and Central North America (with scarce reports from the West Coast), signals from India and nearby Subcontinental environs can be heard at their morning sign-on which in many cases is very close to seasonal sunrise at the transmitter.

The manner by which afternoon longpath signals may rise out of the mud to exceptionally strong, clear and steady levels seems little short of magical at times. Although openings are typically brief, the point has been made that some of these transmitters, most notably from Southeast Asia on skewed paths, simply cannot be heard as well in the mornings here in ECNA. In 1991, John Bryant visited David over the post-Christmas winter holiday period and had his first taste of the 'afternoon Indo' experience. Fortunately there were several excellent openings during his one-week stay. John observed that several Sumatran stations exhibited spectacular peak levels that rivalled the best he had ever heard them at in the morning --- shortpath of course --- from either his principal residence in Oklahoma or even from DXpedition sites on the west coast! Small wonder David has been able to lure Tony back onto the Tropical Bands to scout for the more elusive afternoon Asians.

NON-GREAT CIRCLE PROPAGATION: ADDITIONAL OBSERVATIONS

In retrospect it seems obvious that signals will travel the path of least resistance --- or lowest loss --- between transmitter and receiver. It is also apparent that this will normally be the shortest, or Great Circle path. That these two directions do not always coincide requires explanation. The effect is in evidence daily on higher frequencies, but may be just as common on lower frequencies of most interest here, though masked by the greater difficulty of accurately determining arrival direction on the Tropical Bands. Tony has long struggled towards an explanation of NGC paths and found some clues on the other side of the globe...

TW: *In 1980 I was getting set to journey on DXpedition to the Chatham Islands. These lie about 500 miles east of Christchurch at a latitude of 44 degrees S. I prepared one of my favorite DX tools. This is one of those cheap inflatable, nominally 12 inch, globes. I used one in my Auckland shack on a daily basis. It is suspended between gimbels centered at your own location, and its antipodal point. Ninety degrees from my location I had drawn a new equator, and duly labelled it with the long and short path bearings. It is the quickest and simplest way to establish the azimuth to anywhere on the globe that I know. From Auckland the long path to Britain goes due South over the pole --- close to the SMP and right through the absorption zone. Shortly after sunset each day the path loses its directional stability. On 20 meters, even with my highly successful home-brew 4 element mono-band yagi at 65 feet, signals fade, and become watery. Contact can be maintained over the transition period, which averages about 30 minutes or so duration, by maneuvering the antenna along any bearing from south all the way around to the true short path --- north of course. But on most evenings there is a 10 to 20 minute period when the best signal is to be obtained along a bearing close to 40 degrees. (Figure 8a) Though this had always puzzled me, I had no success at figuring out what was going on with this classic case of bent path propagation.*

Cut to the Chatham trip. On arrival and setup there it became obvious that the path to much of Europe in general and parts of the British Isles in particular was far better than I had ever been used to, despite the use of DXpedition antennas that were good, but in no way comparable to the hardware available at my home station. While the difference was quite marked on 20 meters, on 40 meters it was nothing short of spectacular. And five seconds with the globe disclosed that the true long path bearing to the stations of Eire, for example, was now about 30 to 40 degrees East. (Figure 8b) The puzzle pieces were falling into place. A signal in Auckland heading out over the Pacific on a bearing of 40 degrees or so was intersecting a low loss direct Great Circle path from Chatham to northwest Europe. With a relatively small change of less than 10 degrees, the signal had a low-loss ride for the rest of its journey. What seemed to be a bent path involving a warp of nearly 40 degrees from the Great Circle route was in fact far less spectacular it turned out.

We now believe many examples of apparently large shifts in signal direction originate similarly. Particularly in the case of routes passing through and just beyond the antipodal point, the great circle bearing can vary enormously to locations clustered quite close together. The converse is less often considered but also important. A 500 mile shift in receiver location can make a very large difference in the path to some DX targets, and in particular may, as in this Chatham example, move the great circle route out of the auroral absorption zone. Or, a convenient NGC path may open up as in the case above. The globe deceives us easily.

The significance of this is that we are seeking a mechanism to explain relatively *small* direction changes --- not apparently large diversions --- and this is not a difficult task. McNamara, for example, depicts scattering by "field-aligned irregularities" to one side of a trans-equatorial great circle path causing signal deflection. He comments further that a similar effect may occur on paths near the auroral oval. (McNamara, 1991) We are thus reminded that we have noted the AIR Madras (4990 kHz) signals often appear to be in the process of switching from long path (south from Ontario) to short path as transmitter sunrise approaches, between sign-on at 0000 and 0045, on those occasions when it is heard. We infer this from the watery reception of the relatively high-powered transmitter. In March or April, the signal may peak to the south very briefly at sign-on, fade down, and then peak up again even more strongly on a northeasterly

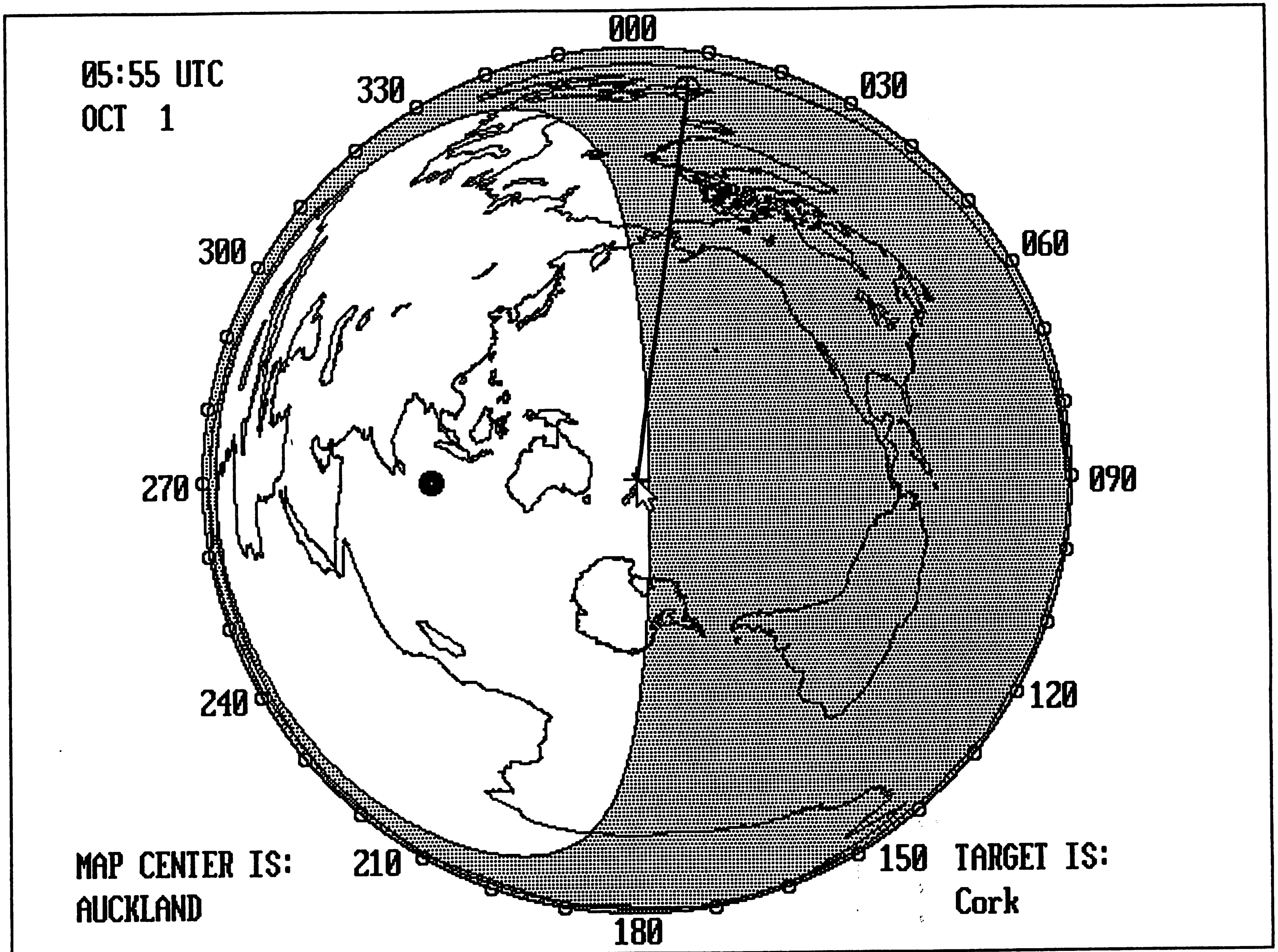

FIGURE 8A: AZIMUTHAL-EQUIDISTANT MAP CENTERED ON AUCKLAND, NEW ZEALAND, SHOWING 0555 UTC OCT 1 POSITION OF GRAYLINE AND PATH TO DX TARGET AT CORK. IRELAND (MAP GENERATED USING DXAID V4)

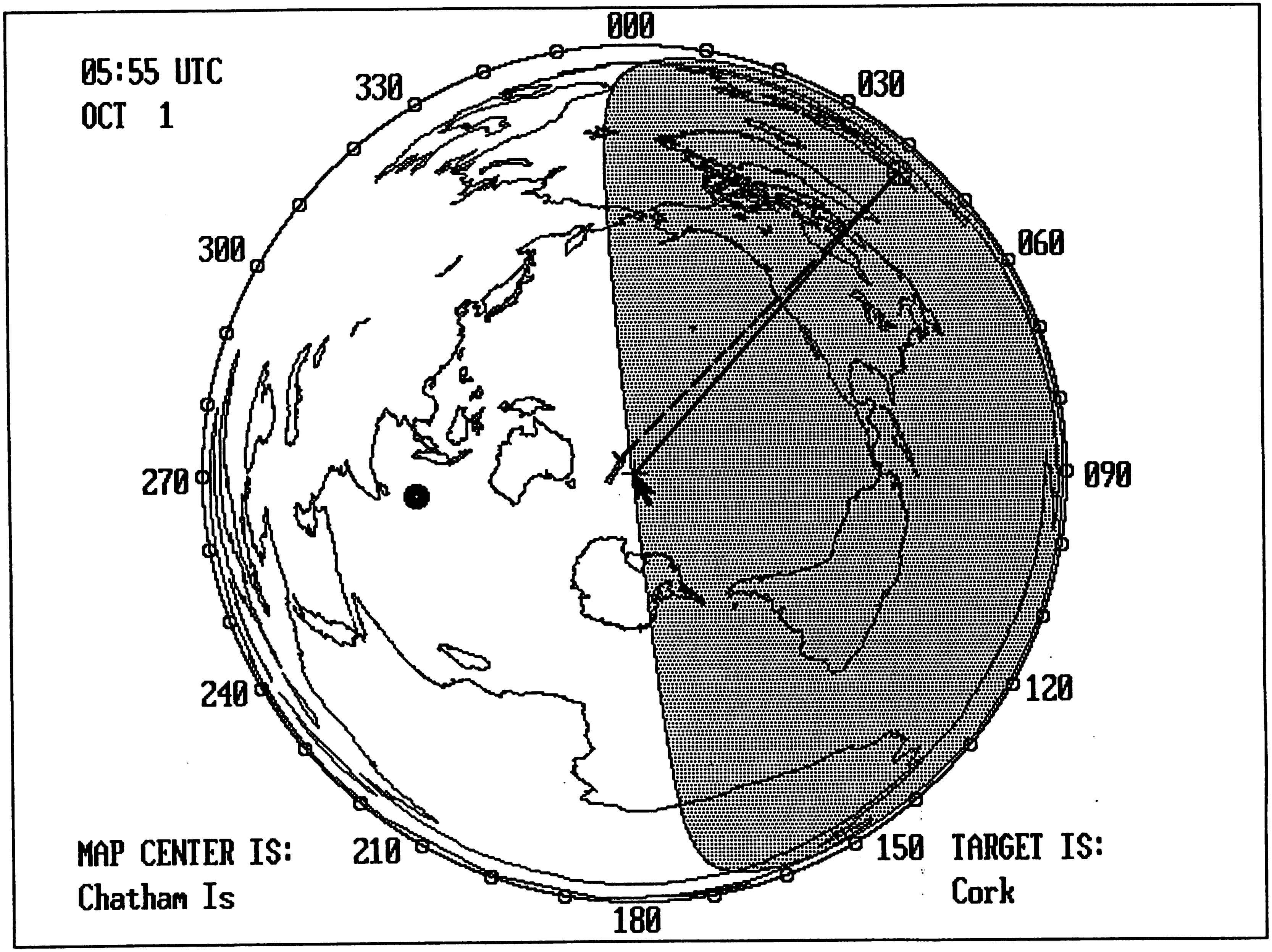

FIGURE 8B: AZIMUTHAL-EQUIDISTANT MAP CENTERED ON CHATHAM ISLANDS, SHOWING 0555 UTC POSITION OF GRAYLINE AND PATH TO DX TARGET AT CORK. IRELAND (MAP GENERATED USING DXAID V4) antenna 30 to 45 minutes later at transmitter SR. In the intervening period the signal is weak and no antenna direction seems particularly favoured. In midwinter, however, solar blanking closes Antarctica to direct signals from the Subcontinent.

Another example: near the Vernal equinox in 1994, the AIR Delhi signal on 3365 kHz exhibited several dramatic occurrences of the apparent switch from long to short path. On more than one occasion, the signal suddenly rose to S9 levels approaching 0105 transmitter SR, then faded sharply just 10 or 15 minutes later.

ANTIPODAL FOCUSSING: THE ULTIMATE IN SPHERICAL CONVERGENCE

That there is an enormous difference in the true bearing to stations not far removed from the antipodal point has been noted above. This is not immediately obvious to most of us living in North America. Most of New Zealand, however, lies directly opposite Spain, and Southern Europe. Over its one thousand miles or so extent from North to South there are quite astonishing differences in the direct paths to and from Spain, Portugal, France, and the many stations of the British Isles in particular. New Zealand hams rapidly get used to hearing their neighbors working stations that are inaudible to them.

Ever since I started DXing from New Zealand --- like David, at about the age of 10! --- I have been aware that certain areas and certain stations were particularly blessed. I was indeed puzzled that the little 1 kW 49 meter outlets that used to inhabit the Tangier special zone were remarkably easy to hear considering their low power. In fact 1 kW omnidirectional from Tangier was considerably easier than 100 kW from Munich, to pick one example. When I migrated to Medium Wave a few years later, it was a poor morning indeed that Nice on 1557 kHz could not be heard. And this was remarkably independent of the conditions on the day.

TW: *Dusk approaches, and the view from my Auckland shack window across the harbor to the setting sun is grand. My NZ call is ZL1AZV, and it gets much airing on the DX and DXpedition frequencies in these declining years of the 1970's. Tonight I swing the ICOM's electronic VFO through 3795 kHz while the tubes warm on the linear. Not much there yet, but the band sounds good, and it's early. Ahah...There's Bill, EA9EO in Melilla, North Africa calling CQ. We have talked many times on 80 meters, because he lives mere miles from my exact antipodal point and there is magic between us in the ionosphere. I run a pair of phased and switchable quarter-wave verticals with 5000 laboriously-laid feet of ground-wire underneath them. "You're not too strong tonight yet Bill, just strength 7, but perfectly in the clear". "Well you're pinning my needle at 20dB over S9 says he...by the way, I'm running the low powered rig tonight...1 watt out." "Hang on", says I, "I'll bring the Argonaut in from the car". 5 minutes later we are in earnest conversation ...ssb...1 watt output each...across half the world.*

Here in the Toronto, Ontario area we are not so fortuitously placed. Our antipodal spot is way out in the Indian Ocean (Figure 9) and we are offered few chances --- particularly away from the ham bands --- to test the character of antipodal focussing. The RRI station at Ujung Pandang is perhaps the best example we have, though focus may also benefit a few other stations in the general region at times. As noted elsewhere, the strength of Ujung Pandang's 60 meter signal is at times quite remarkable. Notice that the long path from Toronto to Sulawesi passes through our antipodal point and somewhat beyond. We think the enhancement effects associated with spherical convergence discussed extensively by Bryant and Clark in their 1990 paper are still a factor.

More than antipodal focus is of course at work here. After all, casting a 4000 Km diameter circle around UJ will encompass many other stations. But few of these also line up on the midwinter grayline at times when that path is far removed from the SMP --- currently off the shore of Antarctica south of Adelaide Australia. This seems to be another of the keys to understanding our relationship to stations on the other side of the globe. The terminator migrates rather rapidly over many of the stations of Asia as the DX season waxes and wanes, but as it moves east of Ujung in early December it starts to run out of steam before backing up to the west during January. This puts UJ in the favoured spotlight for nearly two months. David has found it convenient to recognize the path to UJ as separating two target areas --- one to the east and another to the west --- that behave quite differently at times. Looking at the longpath geometry we see that stations west of UJ can come to us directly via Antarctica only when that continent is in darkness. This is most probable on the shoulder months of the midwinter solstice. But there are times when ionospheric conditions are just right, and these stations seem to duct around the expanding auroral donut and on to us with fine signals indeed. The long path barely reaches east of the UJ line, but the excitement of afternoon West Irian openings has been conveyed above.

SUMMARY AND CONCLUSION

If it was easy we would have had it all figured out by now, and have no need to write this paper, or try to push the envelope out a little further. If it was easy most, if not all of us, would be doing something else. Imagine an electronic ear tag for signals and electronic binoculars to watch. Which way does the signal go? What does it do? How does it change direction? Not in our time...we hope.

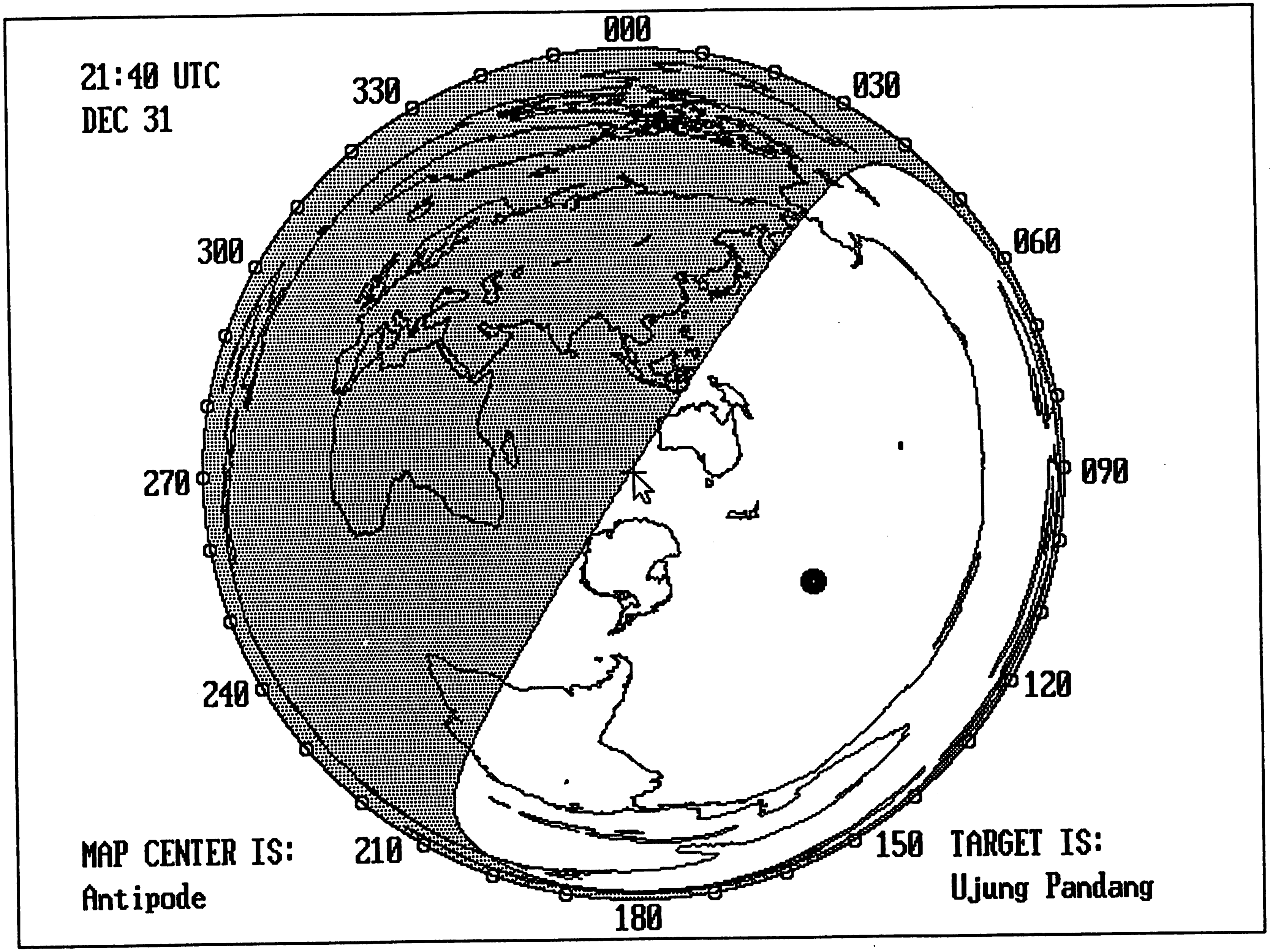

FIGURE 9: AZIMUTHAL-EQUIDISTANT MAP CENTERED ON ANTIPODE OF TORONTO, ONTARIO, SHOWING 2140 UTC DEC 31 POSITION OF GRAYLINE AND TERMINATION OF LONG PATH CIRCUIT (FROM TORONTO) FOR DX TARGET AT UJUNG PANDANG, SULAWESI (MAP GENERATED USING DXAID V4)

Another perspective; possibly the mysteries of HF, and in particular Tropical Band propagation are, like the weather, at least partially chaotic phenomena not susceptible to rigorous predictive analysis. Still, there are certain observations and empirical conclusions based primarily on recurrence that do seem valid to us:

–It is quite clear that dawn and dusk paths --- "partial darkness" paths and sometimes grayline paths --- usually render optimum propagation on the HF bands and this effect is even more apparent on the Tropical Bands. On these lower frequencies, seasonal migration of the terminator is also an important factor in reception patterns.

–Certain twilight paths generally exhibit optimum propagation during an extended period of quiet geomagnetic conditions. But the short and long great circle paths for many signals transported by the ionosphere between Asia and North America are influenced by the presence of the geomagnetic poles and, in particular, the surrounding auroral zones. With the onset of a geomagnetic or an ionospheric storm, the auroral zones become magnetically active or disturbed and apparently are the main contributing factor causing signals to adopt low loss bent or skewed (non great circle) paths which render enhanced reception. The mechanism of enhancement is not yet known but is a ripe topic for further research.

–Non great circle paths, especially long paths, seem to open up more often with the onset of a geomagnetic disturbance. This is usually when signals inaudible or very weak under "normal" circumstances, even on the short path, can be heard at astoundingly enhanced levels on the long path. There is no apparent correlation, however, as might be expected, between optimum reception on the long path and the incidence of solar minimum. If anything, there is a growing body of evidence that the converse may be the case.

–Long path signals from Asia to North America are quite possibly subject to enhancement to varying degrees in complex and compound ways by a variety of other factors, complemented by the onset of a geomagnetic disturbance. These other factors may include spherical convergence and antipodal focussing, the incidence of equatorial and/or mid-latitude spread-F, ionospheric ducting for extended distances, including across the equatorial anomaly, without intermediate, loss-inducing earth reflections, and so on. There are no easy or consistent answers.

Whatever the combination and interaction of contributing factors, signal enhancement and reception patterns on the Tropical Bands --- especially along routes between Asia and North America --- seldom, if ever, fit the mold of conventional theories of HF propagation. The field is still wide open and we, as Tropical Band DXers, can have an important and continuing role in opening up new vistas of understanding and in expanding our knowledge base. To that end, David has compiled a rather exhaustive analysis of Asian reception patterns based on his own DX listening during the 1991 through 1994 Tropical Band seasons. This study was originally intended to form an Appendix to this paper but packaging it in a form that hopefully would be a useful reference for others has proven to be a daunting task that requires more work. It is anticipated that the study will be published at a later date, possibly under the auspices of Fine Tuning's Special Publications. Availability will be announced through the usual hobby media at the appropriate time.

It is increasingly a binary world full of zeros or ones. Applied to the present endeavor this means "we hear 'em or we don't"! But lifting signals above the noise floor is a process with lots of little increments to it, and we hope you have a few more ideas that you can try for yourself than you had before. If we are to raise what we do --- as Tropical Band DXers --- to a science, we need to *understand* what we do. And we need to be able to make predictions that we can test against the real world and modify as necessary. We reiterate once more our feeling that much of the conventional wisdom in propagation research fails to adequately describe what we hear at the dials in our rather cobwebbed corner of the spectrum. But we hope we have signposted some leads to pursue for our future understanding. It is not, strictly speaking, absolutely *essential* that we understand it all of course, but it would make it even more fun than it is already. There are lessons for us all out there...if only in humility!

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APPENDIX A: SOFTWARE AIDS TO PROPAGATION STUDY

Broadcast Engineers have had available to them for some years now a number of path-prediction programs, and the increasing power of personal computers has of course made these readily available to DXers of all stripes. (Sams, 1988) Attempts have been made to apply these to the Tropical Bands with mixed results. We feel that at present mini-MUF and variants bring generally inappropriate and often hidden assumptions to the paths and frequencies of interest here. What DXers need is accurate knowledge of sunrise and sunset times at their own and target locations, and the ability to display the dynamics of path and terminator relationships about the globe. Two DOS programs admirably fit this brief, and we have used both extensively in preparing this paper, and in our DXing.

GeoClock by Joe Ahlgren is in version 6.0 at time of writing, and widely available as shareware on services such as CompuServe, or directly from the author and his own support-BBS. (Joseph R. Ahlgren, 2218 N. Tuckahoe St., Arlington, VA 22205-1946). Peter Oldfield's DXAid is now in a greatly enhanced version 4 and is available from the author. (Peter Oldfield, 251 Chemin Beaulne, Piedmont, Quebec J0R 1K0) These programs complement rather than compete with each other. Both offer accurate determination and display of the position of the terminator and hence grayline on the globe, and have sunrise/sunset information. The Ham extension to GeoClock (available separately) adds an equidistant altazimuth projection map of the globe centered at a location of your choice at time of registration --- typically your home site. The new version of DXAid has an even more powerful feature. By clicking on a chosen location on the main Mercator map of the world you can generate an equidistant azimuth map display centered on *any* location. This is a tool of obvious power in attempting to understand signal paths to distant points --- and in fact Peter was kind enough to add this marvelous feature at our request as we struggled with the preparation of this article.

Since DXAid includes a database of locations (user-editable), *and* propagation prediction routines we commend it to you; with the sole caveat noted above. GeoClock is also readily customizable and comes with a potentially enormous library of detailed maps of the globe that will suit the geographic specialist admirably. You can watch the terminator creep across West Irian in real-time as you DX (with a well-shielded computer system!) or research the exact moment to expect short-lived signal peaks from difficult targets. GeoClock also allows you to animate the display, and it is particularly useful to freeze the sunset terminator at your own location, and watch the march of the corresponding dawn on the other side of the globe, noting the changing distance of this magic line from the SMP for example. You can shift to-and-fro between detailed regional and global views in real- or virtual time at the click of a mouse.

It is difficult to overly-stress the importance of graphic visualization in attempting to understand signal paths, and propagation to distant regions. Few serious DXers are without the DX Edge (Bryant, 1988), and in some respects these two programs start where the DX Edge leaves off. After a considerable battle with a number of serious typographical errors in the published formulae, Tony adapted Devoldere's (1987) favoured algorithm for sunrise and sunset to an Excel equivalent for use with an extensive list of Tropical Band stations. This allows sorting of targets by SR or SS as these change through the seasons, and both Tony and David have found this a useful list to have at their elbows during sessions at the dials.

antennas

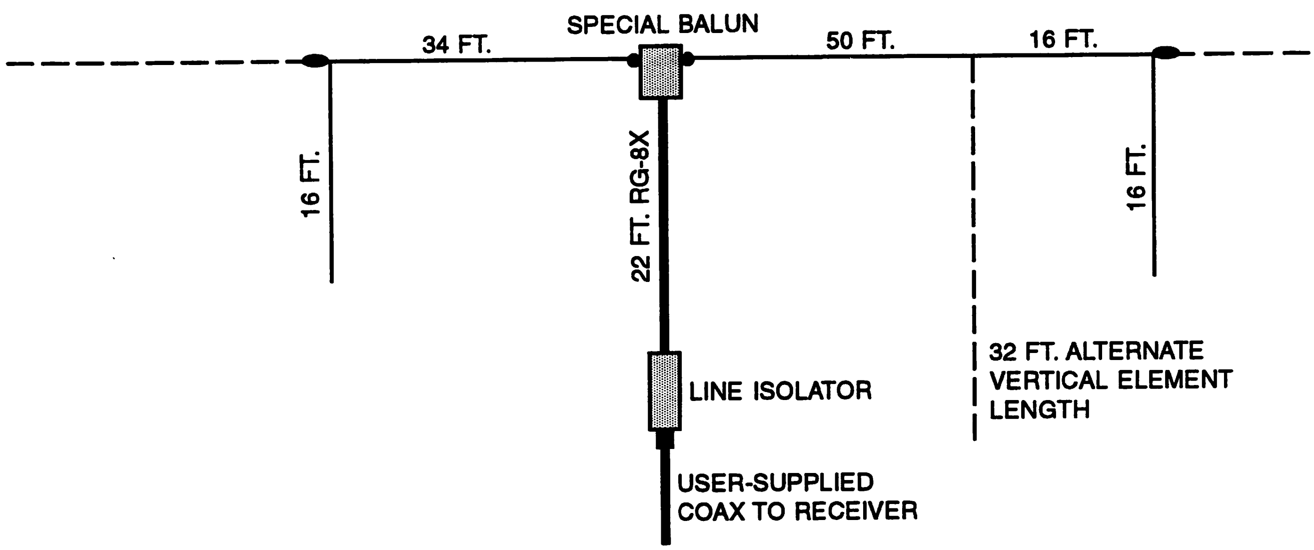
THE CAROLINA BEAM ANTENNA

Guy Atkins with Tony Ward

Despite growth in the number of shortwave listeners during the 1990s, there are still few commercial outdoor antennas designed specifically for the SWBC enthusiast. In comparison the amateur radio community is *much* larger and the ham operator has many more commercial antennas to choose from.

Although it has a ham radio heritage, the Carolina Beam© antenna is useful for the SWBC DXer and it is reviewed from this perspective with an emphasis on tropical band DXing.

The Carolina Beam is one of many high performance wire antennas offered by the Radio Works company of Portsmouth, Virginia, USA[1]. Besides complete antennas, The Radio Works sells insulators, wire, coaxial cable, support ropes, high quality baluns, and some unique items such as Line Isolators© and Remote Baluns©. This firm as well known in amateur circles and advertises frequently in the major publications. Among shortwave listeners The Radio Works is virtually unknown. Perhaps the best known product of the firm is their Carolina Windom© antenna, a star performer during the 1992 Navassa and Albania amateur radio DXpeditions. This is the antenna that the Carolina Beam is patterned after, and the Carolina Windom uses a special impedance matching transformer (balun) and Line Isolator which the traditional windom does not have.



DESCRIPTION

In the words of The Radio Works' catalog, "the Carolina Beam combines the best characteristics of the Carolina Windom and the very high performance wire beam, the Bobtail Curtain".

The [bobtail curtain] antenna system uses the principles of cophased verticals to produce a broadside, bidirectional pattern providing approximately 5 dB of gain over a single element. The antenna performs as three in-phase top-fed vertical radiators approximately 1/4 wavelength in height and spaced approximately a half wavelength. It is most effective for low angle signals and makes an excellent long-distance antenna for either 3.5 or 7 MHz.[2]

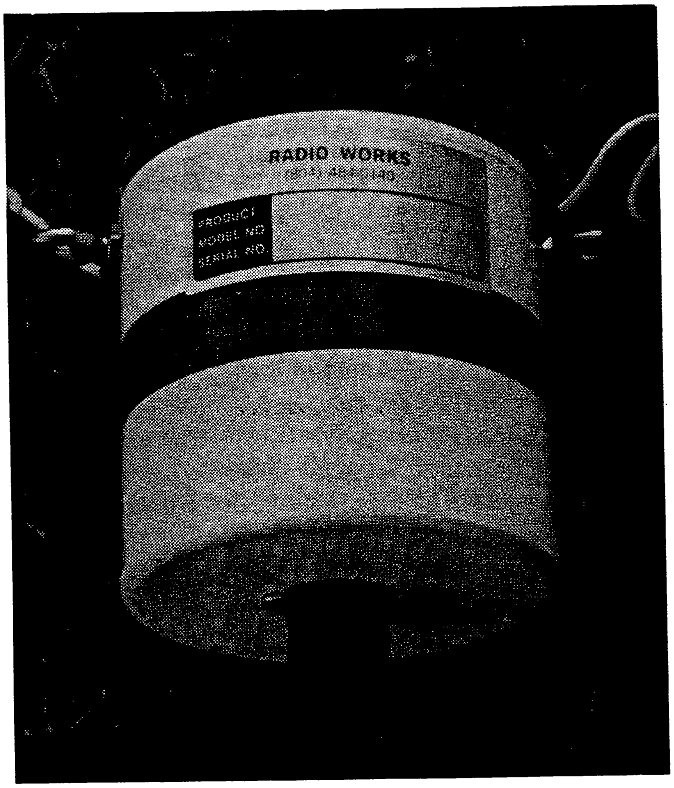
The Carolina Beam does not exhibit real gain below 20 meters. Instead, it performs similar to the Carolina Windom with a low-angle radiation pattern for DX reception and transmission. On higher frequencies its gain is noticeable and useful.

The Carolina beam has the three elevated vertical elements of the bobtail curtain, but has similar horizontal spacing to the Carolina Windom as well as incorporating a balun and Line Isolator. It can be erected to be either 84 or 100 feet long, in either a flat-top or inverted-V configuration. The users manual recommends the 100 ft. flat-top orientation, although reconfiguring to 84 ft. long can be useful in moving the pattern nulls to different azimuths.

The antenna may be erected level or at a slope. Recommended mounting height is 40 ft. or greater, although 30 to 40 ft. is useable. I noticed lower noise levels after raising my Carolina Beam to its current height of 68 feet.

The antenna is rated for 1500 watts on transmit, and a transmatch is required on all bands to ensure low Standing Wave Ratio (SWR). Frequency coverage for amateur use is 80 to 10 meters including the WARC bands.

The Carolina Beam is described in the Radio Works catalog as "the perfect high performance antenna choice for the DXer, traffic-handler, rag-chewer, or *dedicated SWL.*". It was this final phrase and the WARC band coverage that convinced me the Carolina Beam was broadbanded enough for SWBC DXing. Its current price is $99.95 in U.S. funds.



Current-Type Balun for Carolina Beam antenna

CONSTRUCTION

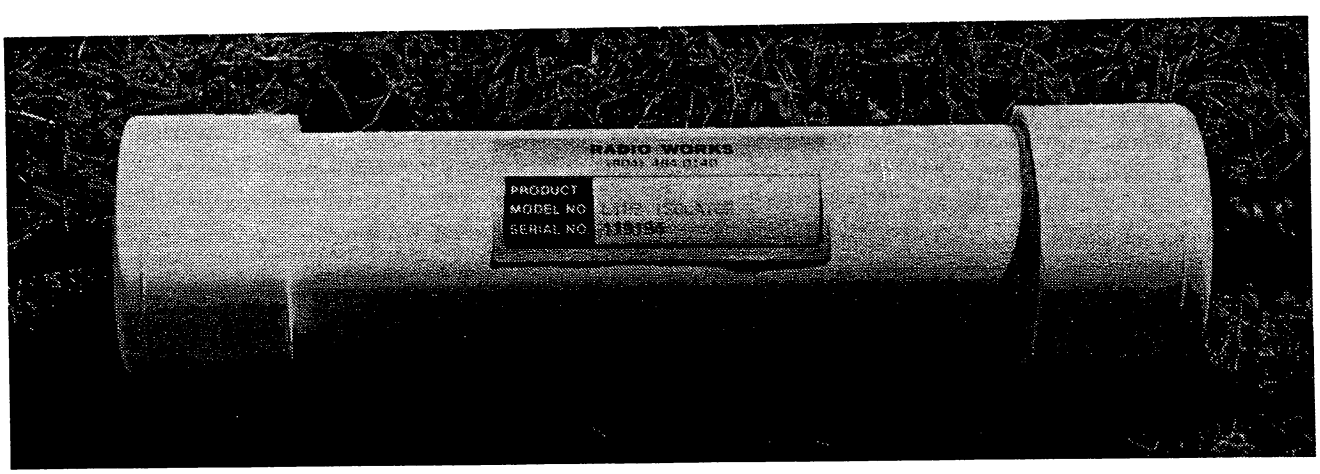
The quality of construction is very high throughout. The antenna uses thick-wall PVC tubing for the balun and Line Isolator housings, 7 x 22 ga. hard-drawn stranded copper antenna wire, glass-filled ABS copolymer insulators, stainless steel hardware, and low loss RG-8X coaxial cable for the center vertical radiating element.

The Radio Works publishes full specifications and bandwidth charts for its current-type baluns and Line Isolators, and it is clear that the firm is proud of the performance and construction of these items. The balun for the Carolina Beam is a special unit that cannot be interchanged with another design. However, it has features similar to other Radio Works' 4:1 Current-Type© baluns: double-cored and wired in a cross-coupled "X" pattern for exceptional output balance and symmetry; a massive toroidal ferrite core; high winding inductance; high feedline isolation; hand assembled and tested to exceed specifications; filled with foam potting compound; and L-C network compensation for a wide bandwidth.[3]

According to Jim Thompson W4THU, president of The Radio Works, the L/C network is a very important part of the balun. The circuit compensates for some of the compromises imposed by this design, and vastly improves the bandwidth and the reactive nature of the balun.

The (SWR) of a Radio Works' balun is typically less than 1.1 : 1 from 3.5 MHz to 28.0 MHz, and rises to about 1.4 : 1 at 1.8 MHz. I believe this nearly flat response is part of the reason for the good performance of the Carolina Beam on the SWBC bands.

What is a Line Isolator? It is a current-type device that operates as an RF choke in series with the outer braid of the coax cable and prevents RF current (transmitted or received) from flowing along the outer surface of the feedline's shield (i.e. *below* the Line Isolator). The Line Isolator has no effect on the signal carried by the cable and does not introduce a reactance that could adversely affect system matching.[4] This unit allows the center vertical element of the Carolina Beam to function both as feedline and vertical radiator. According to The Radio Works, the Line Isolator is much preferred over a coiled-coax type of choke, which is useless below 14 MHz because inductance is too low.



Line Isolator for Carolina Beam antenna

The center vertical element of the Carolina Beam is a key to its good low angle response. The Radio Works catalog states that

> "The Carolina Windom has popularized radiating feedline sections that improve low angle vertical radiation. Extensive computer analysis has shown that improvement in vertical patterns can be applied to other antenna types. The technique is called "VERT", Vertically Enhanced Radiation Technique... [antennas using VERT] have the advantage, increasingly, as the propagation favors longer propagation paths. Daytime, high angle operation will show little difference."

Radio Works' products that incorporate the VERT principle include the Carolina Windom, the Carolina Beam, Vertical Radiating Dipole, and Dipole/2 antennas.

The Carolina Beam comes with a fifteen page users manual that contains sections on installation, troubleshooting (from the perspective of ham-band transmitting), coaxial cable lengths, weatherproofing, and performance (general comparisons to a Carolina Windom and halfwave dipoles).

To help keep the vertical elements at the ends from swaying in light breezes, I attached two 1-lb. lead weights at the bottom of each wire. I also use 12" long, screen-door springs between each support rope and the antenna end insulators, which should help the antenna to survive moderate wind storms.

PERFORMANCE

For performance comparisons, the Carolina Beam was erected between tall cedars at a height of approximately 50 feet in the 100 ft., flat-top orientation. The axis of the antenna runs NW-SE, giving a broadside directionality that nominally favors Australia/South Pacific and Europe/Africa. In practice I have found the antenna to work well in all directions, but directionality increases on the higher (daytime) bands.

My home is located on a small island in a good-sized lake. Some antenna texts indicate that the far-field radiation/reception patterns are affected by ground conductivity changes such as those from bodies of water. The performance of my antennas may be enhanced or changed by the surrounding lake.

Initially the Carolina Beam was compared to my other DXing antenna, a terminated (500Ω) 300 ft. "mini-Beverage" that is coax-fed through an impedance matching transformer and separate ground system. The mini-Beverage is directional off the far end at 260 degrees true north and performs very well for reception from Papua New Guinea and Irian Jaya. The main downfall of the mini-Beverage is noise pickup from nearby homes.

For tropical band stations located "down the barrel" of the mini-Beverage, signal strengths on the Carolina Beam are usually somewhat less. However, reception is often better due to less noise. During quiet conditions with threshold-level signals the mini-Beverage outperforms the Carolina Beam, but only for tropical band Papua New Guinea and Irian Jaya stations. In all other directions and frequencies the Carolina Beam is a better performer—often by as much as 5 S-units—especially on the higher frequencies.

A more realistic antenna for comparison is a 100 ft. randomwire, typical of what many shortwave listeners use. The following chart compares reception between the Carolina Beam, a 100 ft. randomwire (inverted-L), and an impedance-matched 100 ft. randomwire (using the same matching transformer and separate ground system as the mini-Beverage described earlier). The 100 ft. randomwire was connected directly to the 500Ω input of a Drake R8 receiver, and the other antennas were directed to the 50Ω unbalanced input via a coax switch. Both randomwires were erected 25 ft. high. (Note: refer to the article "Impedance Matching for Simple Wire Antennas" elsewhere in this edition of *Proceedings 1994-95* for details of improving reception with matching transformers.)

The charts on the following pages show that the Carolina Beam sometimes made the difference between hearing or not hearing a particular station. (Note the randomwire entries marked *barely audible* or *not audible.*) This was true more often on the higher frequencies, where the Carolina Beam's gain and low-angle reception out-performs a simple randomwire. "QRM" in the charts is used in the SWL sense of the term: local man-made sources such as light dimmers, powerline hash, and other RFI, rather than adjacent or co-channel stations.

The Carolina Beam and the two randomwires had approximately the same performance on the 25 meter band; on every other band the edge went to the Carolina Beam, sometimes by a significant margin.

I expected the Carolina Beam to be a good DXing antenna due to its low radiation angle, but I did not expect the lower noise levels. This was a pleasant surprise! A further reading of The Radio Works catalog revealed information I had overlooked previously: the Line Isolator can often reduce noise at the receiver:

> *Here is one explanation for the noise reducing action of the 4KV-LI [Line Isolator]. There may be very low level RF current flowing through or along the surface of the ground (earth). Fast rise-time pulses created by motors, switches, leaky insulators, etc. produce RF energy that we hear as noise. Several houses in a neighborhood are connected via the power lines. Unfortunately, improper grounding of household systems is more the rule than the exception. A complicated electrical network is established. RF (noise) current may be flowing between houses or electrical power ground systems as our modern household noise makers seek a path to ground.*

FREQUENCY	STATION	CAROLINA BEAM	100 ft. w/Matcher	100 ft. Hi-Z
2325	VL8T Australia	S-6	S-6 + strong QRM	S-6 + strong QRM
2340	Fujian PBS, China	S-5	S-5 + strong QRM	S-5 + QRM
2485	VL8K Australia	S-5 + slight QRM	S-5 + QRM	S-5 + QRM
2500	WWV	S-6	S-5	S-5 + QRM
3220	CPBS1, China	S-8	S-5 + QRM	S-5 + QRM
3245	AIR Lucknow	S-5	S-2	S-3 + strong QRM
3250	PBS, Pyongyang	S-7	S-4 + QRM	S-4 + strong QRM
3255	BBC, Lesotho	S-5	S-3 + QRM	S-4 + QRM
3260	PBS, China	S-5	S-3 + QRM	S-3 + strong QRM
3265.1	RRI Bengkulu	S-5	S-3	S-4 + QRM
3300	R. Cultural, Guatemala	S-7	S-5	S-5 + QRM
3320	PBS, Pyongyang	S-7	S-5	S-5 + QRM
3330	CHU, Canada	S-6	S-4	S-5 + QRM
3335	BCC, Taipei	S-4	S-2	S-2 + QRM
3395.1	RRI Tanjung Karang	S-5	S-2	S-3
3915	BBC Singapore	S-7	S-5 + QRM	S-6 + QRM
3925	R. Tanpa, Japan	S-7	S-5	S-5
3981.1	Unid. stn. (China?)	S-5	S-5 + QRM	S-4 + QRM
4740	R. Yunost, Tajk.	S-4	S-1	S-3 + QRM
4753.3	RRI Ujung Pandang	S-7	S-6	S-7
4770	V. of Nat. Salvation	S-6	S-5	S-6
4800	LNBS, Lesotho	S-5	S-5	S-5
4815	R. China Int'l., China	S-4	S-4	S-4
4840	V. of the Strait, China	S-4	S-2 + QRM	S-2
4860	R. Moscow? Russia	S-4	S-4	S-4
4875	V. of Jinling, China	S-6	S-5 + QRM	S-5
4915	Guangxi PBS, China	S-6	S-5	S-5
4920	R. Quito, Ecuador	S-3	S-2	S-2
4970	RTM Kota Kinabalu	S-5	S-5	S-5
4991	R. Ancash, Peru	S-4	S-2	S-2 + QRM
5000	WWV	S-7	S-7	S-7
5975	BBC, Antigua	S-9	S-8	S-8
6060	R. Australia	S-8	S-6	S-6
6165	R. Nederland, Neth. Antilles	S-7	S-5	S-5 + QRM
6195	BBC Singapore	S-6	S-5	S-5 + QRM
7250	R. Moscow	S-9	S-7	S-6 + QRM
7355	WYFR, USA	S-7	S-5	S-4 + QRM
7412	AIR, Aligarh	S-4	S-2	S-2 + QRM
7425	WEWN, USA	S-6	S-4	S-4
9515	BBC, Sackville	S-5	S-3	S-3 + QRM
9580	R. Australia	S-9 + 20db	S-8	S-7
9650	DW, Germany	S-6	S-6	S-6 + QRM
10000	WWV	S-9 + 10db	S-9	S-9
11625	Vatican R.	S-2	S-1	S-2 + QRM
11680	China R. (Fr. Guiana)	S-9 + 20db	S-9 + 20db	
11695	R. France Int'l.	S-4	S-4	S-4 + QRM
11760	R. Havana	S-9	S-9	S-9 + 5 db

FREQUENCY	STATION	CAROLINA BEAM	100 ft. w/Matcher	100 ft. Hi-Z
11795	DW, Germany	S-6	S-5	S-5
11805	R. Moscow, Kazan'	S-3	S-2 + QRM	S-2 + QRM
11826.8	RFO Tahiti	S-7	S-5	S-6
11930	VOIRI, Iran	S-5	S-5	S-5
11940	R. Jordan	S-9	S-7	S-8
11945	UAE R., Dubai	S-8	S-7	S-7
11950	Kazakh R.	S-7	S-5	S-6
11960	HCJB, Ecuador	S-7	S-7	S-6 + QRM
12040	Unid., rel. pgm.	S-2	barely audible	barely audible
12060	R. Moscow (Armenia)	S-3	barely audible	not audible
13595	WJCR, USA	S-8	S-7	S-7
13605	R. Australia	S-4	S-2	S-4
13675	UAE R., Dubai	S-7	S-6	S-7
13700	R. Nederland (Flevo)	S-9	S-8	S-9
13740	VOA, Ohio	S-9 + 5db	S-9 + 5db	S-9 + 5db
15000	WWV	S-9 + 10db	S-7	S-7
15029.6 USB	RFPI, Costa Rica	S-3	barely audible	barely audible
15050	AIR, Delhi	S-6	S-3	S-4
15155	HCJB, Ecuador	S-9 + 10db	S-8	S-9
15168.9	RFO Tahiti	S-7	S-5	S-6
15220	R. Moldova Int'l.?	S-3	not audible	barely audible
15230	R. Japan	S-8	S-5	S-4
15240	R. Australia	S-9	S-5	S-6
15245	R. Moscow (site?)	S-4	barely audible	barely audible
15310	BBC, Oman	S-6	S-4 + QRM	S-5
15345	VOFC, Taiwan	S-9	S-5	S-4
15355	R. Japan	S-9 + 10db	S-8	S-9
15360	BBC, Singapore	S-5	barely audible	barely audible + QRM
15365	R. Australia	S-8	S-5	S-6
15390	BBC, Ascension	S-9	S-5	S-8
15400	VOA, Greenville	S-8	S-5	S-6
15435	R. Jamahiriya, Libya	S-5	S-2	S-3 + QRM
15445	R. Pakistan	S-5	S-3	S-4
15460	R. Moscow, Krasnoyarsk	S-6	S-3	S-5
15490	R. Moscow, Tula	S-5	S-3	S-4
15505	R. Kuwait?	S-5	barely audible	barely audible
15475	Africa Numero Un	S-4 + QRM	S-2 + QRM	QRM only
17760	R. Pilipinas, Philippines	S-5	S-5	S-4
17775	KVOH, USA	S-7	S-7	S-7
17790	BBC, Ascension	S-6	S-6	S-6
17795	R. Australia	S-6	S-6	S-7
17845	R. Japan	S-7 mixing w/VOFC	S-7 Japan only!	S-6 Japan only!
17890	R. Moscow, Irkutsk	S-6	S-5	S-5
18640	unid. FAX xmsn.	S-4	S-1	S-3
21455 USB	HCJB, Ecuador	S-2	barely audible	S-2
21475	VOA, Philippines	S-7	S-4	S-5
21480	R. Moscow, Petropavlovsk	S-9 + 10db	S-8	S-9

A well installed vertical antenna will have two ground systems. One is at the antenna and the other is at the radio equipment end of the coax. We have different ground systems at each end of the coax feedline. A voltage gradient probably exists between the two grounds. The differential voltage between these two grounds will be conducted directly by the coaxial feedline and coupled to the station receiver. We hear the result as noise. The 4KV-LI [Line Isolator] isolates the two ground systems from one another and reduces the noise pulses that may be flowing along the coax. This is, of course, only one explanation. The capacitive coupling between coax and ground also will have a similar effect.[5]

The above explanation applies directly to a vertical monopole with a ground connection. All antennas, however, form an electrically complicated system affected by other antennas, local RFI, transmitting/receiving equipment, antenna feedlines, ground system(s), and nearby metal objects. The Line Isolators sold by The Radio Works have negligible loss and are worth experimenting with in any coax-fed antenna system.

In an urban or suburban environment the noise level is the limiting factor in DX reception, and the Carolina Beam is an unusually quiet—and unconventional—antenna. I have not directly compared the Carolina Beam to a delta loop antenna, but going from memory it seems to be as quiet an antenna as the 60 meter band delta loop I have used.

Ontario DXer and *Proceedings* author Tony Ward purchased a Carolina Beam after hearing of my good results. He is in the fortunate position of DXing with a number of longwire antennas about 500 feet long, which are lengthy enough to be considered true Beverage antennas (unterminated) on many frequencies. How does the 100 foot Carolina Beam compare with a Beverage, usually considered the ultimate antenna for the serious SWBC DXer? Surprisingly well, according to Tony:

"The Carolina Beam is performing well, even at its low (25 feet at the house, 35 feet at distant end) elevation. I would expect this in a vertical array. It occasionally equals my longwires on the evening long-path, but has never beaten them (ie the best-performer on a given station) so far. If you had no room for long-wires it would be considered a superb choice for a single antenna. On the morning path (when my antennas have to work off their feed-ends — it is normally the best performer on 60 & 90 meters by an S-unit or more. Some mornings saw it bring in Indians inaudible on any long-wire... I am well pleased.

Because of the peculiarities of my location I can run longwires radially from North around to South towards the east. This means I can direct them towards the evening long-path (NE, SE etc) but they must work off the fed-end back at the house on the morning Asian short-path to west and north-west. I currently have 4 (soon to be 5) of these unterminated long-wires up, and they are all about 500 feet in length.

The overwhelming advantage of the long-wire is its extreme simplicity, and great directional performance. The Carolina Beam was originally installed in its long mode, with two 16 ft. and one 22 ft. vertical elements. The 16 ft. element closest to the house as less than 10 ft. from aluminum siding, and I could not see it performing fully to spec. I recently reversed the antenna, which allowed me to dangle a now 32 ft. vertical element from the top of the tree at the back of the house — a 50 ft. support. The shortened horizontal extent of the antenna in this format carries the housewards (west end) 16 ft. vertical a further 20 ft. away from the siding, while keeping the 22 ft. driven vertical on my own property. Preliminary results confirm the expected improvement in low-band performance. At sunset tonight, for example, Ghana on 3366 was slightly stronger on the Carolina Beam than on the best longwire. Stations now runs neck-and-neck with the Carolina Beam — not bad at all for a single antenna versus four others to choose from.

Daybreak monitoring shows that the Carolina Beam maintains its advantage into Asia on mornings when low-angle signals are arriving. During the daytime it makes an excellent all-purpose receiving antenna on the higher frequencies, sometimes with the edge, other times not (as expected). Low angle late afternoon Asians are often better on it (Delhi 9910, Korea 15575) but most signals are coming in at fairly high angles, where almost any antenna will work.

Tonight I tuned Radio New Zealand on 15115 at about 2300, 45 minutes before my local sunset. The best antenna was the 75 degree longwire — working off its rear without a doubt — by about 2 S-units. A recheck at 0120 showed a dramatic reversal of the situation. On the longwire the signal was a watery S3-4, with occasional peaks to S6. On the Carolina Beam however the signal was a perfect S9+10 to 20dB. This is on the R8, pre-amp off. Presumably the propagation was low angle, and particularly suitable to the Carolina Beam. The Carolina Beam had the edge up and down the band on many stations at different distances, but the advantage was most spectacular on RNZ. The sucker's paid for itself!

One further comment is important. Long-wires are desirable because of directional gain, good signal/noise ratio, extreme simplicity, AND the less-often mentioned but rather important factor of resistance to short-term fading. Long-wires often seem to hear better because signal strength gathered along their appreciable lengths is steadier and less choppy. I notice this diversity effect in favour of the long-wires, even when the Carolina Beam leads in peak signal strength. But the Carolina offers excellent performance for its size, and for situations in which there is a one-antenna limit, it's unbeatable."

FINAL COMMENTS

Some weeks after my comparison testing, I lowered the antenna to take close-up photographs. I was surprised to discover that the Line Isolator was filled with a considerable amount of water! I thought I had thoroughly waterproofed all connections and seams with the supplied Coax Seal© but I clearly missed something. I drilled two small holes in the lower cap of the Line Isolator to drain the water, and then plugged the holes. The owner's manual recommends complete weatherproofing, and they aren't kidding. I do not know if the unit was waterlogged during my comparison tests, but dry Line Isolators and baluns are certainly preferred! I later discovered that water had entered the unit where the coax exits the top of the Line Isolator. VERY liberal application of Coax Seal© is my recommendation.

The excellent low-angle reception pattern of the Carolina Beam has been emphasized in this review. However, the antenna's horizontal element also contributes to its all-around performance. Unlike Tony Ward, I prefer the 100 ft. long configuration for best tropical band performance at my location. I have switched between the two lengths a number of times and continue to like the 100 footer below 5 MHz. Fortunately it is a ten minute job to reconfigure the length of the Carolina Beam.

The Radio Works company would be wise to advertise this antenna in the SWL community, perhaps after "tweaking" the antenna to our frequencies of interest. At $99.95 the Carolina Beam is an excellent value. It's ironic that the best commercial antenna I've ever used for SWBC DXing—the Carolina Beam—is an amateur radio antenna!

REFERENCES

[1]The Radio Works Inc., P.O. Box 6159, Portsmouth, VA 23703. Phone: (804) 484-0140; fax: (804) 483-1873. A price catalog and a 128 page Reference Catalog are available together for $6.00 postpaid (inquire directly for pricing to Canada and foreign addresses). The Reference Catalog is particularly useful to antenna experimenters; it contains a wealth of "how-to" information, antenna construction and maintenance tips. Highly recommended!

[2]The ARRL Antenna Handbook, 14th Ed., American Radio Relay League (ARRL), Newington, CT 06111; "Multielement Directive Arrays", pg. 6-13.

[3]The Radio Works Inc., *loc. cit.*

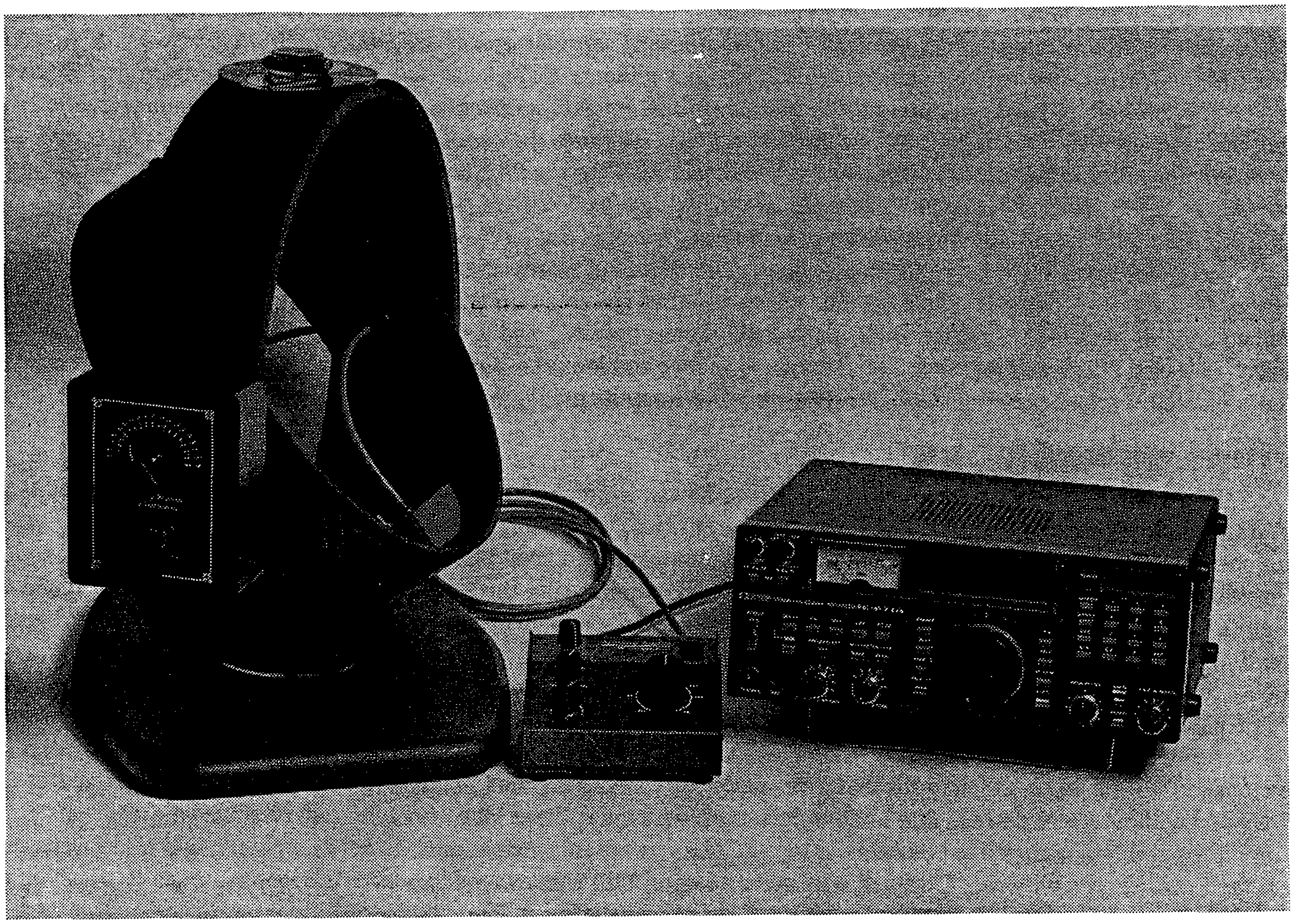
[4]The Radio Works Inc., *loc. cit.*

[5]The Radio Works Inc., *loc. cit.*

THE KIWA MEDIUMWAVE LOOP ANTENNA

Everything I ever wanted in a mediumwave loop and more

Werner Funkenhauser



PREAMBLE

Back in 1958, I bought a SONY 9 transistor BCB portable which taught me about loop antenna direction and nulling. Along the way, I also discovered that nulls could be improved by tilting the radio. My High School shop instructor just shook his head when I explained why I built a tilting "Lazy-Susan" cake-server with a SONY radio fastened atop. Since then, I have used all kinds of loops, air and ferrite core, shielded and unshielded. Most were unamplified but some had amplifiers, including the regenerative variety. Those were sensitive but generally unstable, easily breaking into uncontrolled oscillation. As well, they were critically sensitive to detuning because of hand capacitance. Over the years I came to prefer large air core loops. I found that unlike the ferrite variety, large loops seemed to provided deeper nulls and gave good signals without the need for amplification. This type performed well in noisy conditions and considering my engineering skills and carpentry methods, they were electrically if not physically stable.

The Kiwa Loop's advance publicity now almost two years ago, spoke in terms like "compact", "stable regeneration" and "balanced" design. The idea of a small, high-performance, circular loop with tilt capability and regeneration interested me. I wondered how it would compare to a Connelly wire/loop phasing unit which I used with a 1 meter air-core loop? Frankly, I didn't think that pair's performance could be improved. They had rewarded me with logs of Quito's HCRP1 on 880, and Buenos-Aires' LRA-1 on 870. The 1 meter loop with Connelly's phasing unit was my benchmark against which I compared all other loops. Still, I was curious.

SOME MORE OVERVIEWS AND OPINION

My friend George Hakiel, told me he suggested using regeneration to the Kiwa's designer, Craig Siegenthaler, at an IRCA Convention. At the time, Siegenthaler was still formulating his product. During preparation of this piece, Siegenthaler wrote me, *"The idea to develop a MW loop antenna began at an IRCA get together in Seattle when I had a chance to see a popular ferrite loop in operation. It performed well, but when studying the design, I thought there were ways to improve the mechanical requirements. The tilt control was difficult to use and often the presence of one's hand upset the null position due to body capacitance."*

In the same letter he described the loop's theory of operation. *"It is a balanced design of two identical sets of coils. The antenna windings are tuned with a matched-pair of varactor diodes used as capacitors for tuning of the coils. This balanced assembly drives a matched pair of surface mounted FETs whose output drives the regenerative windings for bandwidth/gain control. The same FETs also drive a balanced (matched pair FET) differential amplifier where the outputs of each antenna coil/preamp is summed together, allowing the cancellation of noise that might be common to both antenna coils. Noise pickup from power lines is heavily filtered with circuitry that "scrubs" the AC before reaching the DC rectifier/filter. The summed signal is sent to the control surface from which two buffer amplifiers drive two isolated 50 ohm outputs. The preamplifier also acts as an active Balun."*

Craig designed his loop to overcome major shortcoming of many other loops. He addressed obvious problems and engineered stability, balance, and ruggedness among other features into the design. As well, he considered aesthetics, for which I'm glad. Some commercial loops look "home-brewed" and are just plain ugly. The Kiwa is stylish, "art-deco" in looks. Operating features, excellent performance and looks embodied in one design, undoubted factors considered by WRTH when granting the Kiwa Mediumwave Loop its prestigious "1994 Product Of The Year Award".

FIRST IMPRESSIONS

Harold Sellers obtained of one of the earliest Kiwas which he let me use for awhile during late Spring of 1993. *That test was an eye-opener!* The Kiwa was highly sensitive, very stable and suffered no hand capacity detuning unless touched. After coming away from my trial, my only complaint was that tuning was somewhat easier on lower frequencies than at the high end where it was more critical. However, using the antenna was simple. First I coarse tuned the frequency of a station, then fine-tuned it, adjusted the loop for maximum null, reduced RF gain then advance regeneration. Several tilt/aim trials with a little more fine-tuning/regeneration adjustment to tighten nulls and reduce noise/QRM topped off the process. A lot of twiddling? Only the first few times, and much easier to do than to describe. The sequence quickly became automatic.

Among my logs, I counted HCRP1-880 and KPRM-870 on nighttime power of 1 kW (despite WWL and WHCU). I managed several 1610-TIS stations that were easily separated from the Caribbean Beacon. The Kiwa had features that I wanted without shortcomings that I had experienced with many other loops, including my beloved 1 meter unit. I was impressed and felt qualified to comment in my *DX Ontario* column "Mediumwave International", and also discussed it on the FIDO shortwave echo. I wanted one! After reading Phil Bytheway's "Kiwa MW Loop Antenna Review" in the NRC Bulletin, I wanted one even more but held off because of cost. The clincher was having to DX with a McKay Dymek DA-5 attached to my ICOM R71A. My 1 meter loop was gone, thrown out by my former landlady when I moved and forgot to bring it along. In fairness, the DA-5/R71A were very good together. After years of hearing time pips and tentative IDs on 870 kHz, in November 1993 I had a spectacular 20 minute reception with that setup. It earned me a much-treasured LRA-1 QSL. Based on my experiences with Harold's Kiwa, I was certain it would have performed better under similar circumstances. Shortly after Christmas I ordered one directly from Kiwa, and spent several weeks waiting for it come. Somehow they seemed longer.

DESCRIPTION

The loop arrived via UPS in a single box, protected with expanded foam and newspaper padding. There were four pieces – the antenna assembly and its cable, the base, a control box which Kiwa calls a "control surface" and a wall-plug power supply. Small parts and manual were in a separate bag. Everything was unpacked, assembled, and *ready to go in 10 minutes!* Mechanical installation involved attaching the loop to its base with a large nylon bolt and a lucite washer between the two pieces. Assembled, the Kiwa's black teflon-coated finish with its artistic white control labels reminded me, like Bytheway, of nostalgic equipment.

The antenna's eight foot cable attached to a DIN receptacle on the back of the control surface. This cable may be as long as fifty feet and custom lengths fitted with DIN hardware can be ordered from Kiwa. Longer cable allows remote operation in the event of electrical or receiver display noise.

The AC power supply plugged into the back of the control surface. The Kiwa may be powered with 13.7 VDC from an automotive battery through two polarity-marked terminals. The DC power source is diode-protected and impossible to damage through a reverse polarity error. The antenna just fails to work.

All that remained was the receiver connection. Output from the control surface is via two PL-259 sockets. Either 75 ohm or 50 ohm coaxial cable with appropriate connectors may be used, but 50 ohms is recommended. The receiver can be connected to either output, or two receivers can be connected to the antenna at the same time (handy on a DXpedition and for sideband-diversity reception). I connected both outputs to the Icom's two antenna inputs. The R71A's mediumwave range (antenna B) cuts off at precisely 1600 kHz and I often tune above that frequency for out-of-band mediumwave DX. Routing the cable to the Icom's antenna A (the PL-259 socket) through an antenna switch allows me to select between Kiwa or a random wire antenna for shortwave reception as I continually look for parallel programs on those bands.

AIMING AND OTHER CONSIDERATIONS

The Kiwa's reception pattern is the classic figure eight. Like Bytheway, I measured this simply by aiming for maximum signal on a local station then I swung the antenna around 180 degrees. S-meter readings were exactly the same! This test was conducted with local station signals during daytime, on the yard, and well away from house wiring and furnace ducts. Good equal nulls without the need for tilting occurred exactly 180 degrees apart in a similar swing-around test.

Mounted atop the loop is a compass which may be used to read station bearings directly. After I aligned the compass with true North, I could aim the antenna for maximum signal along its plane and read the station bearing in degrees. The accompanying manual gives good examples of how to determine true North. I photocopied and enlarged one of Cedric Marshall's ODXA Sunrise-Sunset azimuthal maps centered on Toronto. After trimming it I punched a hole at the centre and placed it between the lucite washer separating the antenna from its base. Aligned against the compass, the map provided a large scale that could easily be read with an indicator taped near the base of the loop.

Bruce Portzer, one of the original beta testers of the Kiwa loop, commented after reading my draft article. *"You might also talk about nulling locals by alternately tweaking the azimuth and tilt controls until the local loses out (hopefully) to the DX station. I've gotten my best nulls of all times on the Kiwa (after having previously used a Radio West 12" ferrite, 4 foot box loop and a Space Magnet)."*

Located inside the antenna hoop, at the bottom, is a plastic mini-box that houses a 25 db attenuator switch. A dummy box mounted inside, at the top, acts as a counterweight. The 25 db attenuator substantially reduces strong signals and thus the receiver's AGC action. That materially helps to find optimum tilt-angle and azimuth to null locals. Signal peaks and nulls are very sharp, but accurate adjustments which yield good results are easy to make. The antenna assembly with base are heavy and physically stable and the antenna rotates freely without binding on its base. Weight, size and action permit smooth direction adjustment. Tilt operations have little or no backlash. Smooth action of the knob-driven tilt mechanism on the front of the antenna is accomplished through a precision gear mechanism. A large tilt angle scale is marked 90 degrees left or right of vertical. As with aiming, the loop's sturdiness, weight, and size all contribute to stability and backlash free tilt procedure. All-in-all, repeated adjustment of tilt and direction is a snap. However, I found the location of the 25 db attenuator switch awkward. It's position on the antenna element made it too easy to inadvertently change the tilt-angle when switching it out.

OPERATING FEATURES AND PERFORMANCE

I've been using my Kiwa for over two months and it outperforms both the DA-5 and a new 1 meter loop. It consistently delivers stronger signals than either, and its excellent smooth tilting action helps reduces local electrical noise while providing excellent nulls.

Compared to the DA-5, the Kiwa's sensitivity seems markedly better without regeneration, but when regeneration is set at the maximum usable level (just below the point of oscillation), the Kiwa's weak signal capability is far superior to the DA-5's. When properly set in this mode, the amplifier showed no susceptibility to overload from strong local signals and I found no unexpected birdies or signals from strong locals appearing in odd places on the dial.

The manual warns about keeping the antenna away from nearby metal objects and interference sources, including the receiver. Metal objects may degrade the receiving pattern. Modern digital receivers often produce display noise and some older receivers with poor shielding may generate internal signals which the antenna is capable of receiving. I located my loop about 4-5 feet away from my Icom R71A and have few problems from its noisy display, except when signals are really weak. Then I get a little warble on certain frequencies. My listening location, in the basement of a "row-house" is very noisy because of many nearby electrical appliances. I operate below ground level, 20 feet away from the furnace whose ducting runs across the ceiling along with assorted TV, telephone and electrical cables some of which are also found in the walls. This speaks highly of the Kiwa's usefulness under degraded listening conditions. However, background noise may be masking some of the Icom's weaker display noises and so I want to try remote operation with the Kiwa on a rotator under some kind of dome and away from the townhouse. The possibility of having to forego the loop's tilt capability is an important impediment that has kept me from doing so yet. Tilting is absolutely essential for maximum nulls and noise cancellation.

The Kiwa performs very well to deliver DX in the presence of nearby co-channel stations. First, the local is nulled and then the DX signal is fine-tuned without readjusting the antenna. In this case, the antenna may not be aimed/tilted for maximum DX signal level, but it is often possible to raise its level substantially through a combination of regeneration and fine-tuning. As Ken Cornell stated in one of his articles describing the construction of a regenerative loop, *"If you've never used a regenerative amplified loop, you're in for a treat. Weak signals seems to pop up from beneath noise."* The Kiwa is not unlike other regenerative antennas in this regard. Unlike others however, the Kiwa remains stable at near-oscillation. In this mode, it behaves as a kind of passband device, like IF passband tuning or crystal phasing, but at RF frequencies. Near regeneration, the antenna is sharply frequency-selective. The signal may be made even more intelligible by fine-tuning either upper or lower sidebands for both audio shaping and QRM reduction. It is often possible to use a broader IF filter in this mode, increasing signal intelligibility even further.

The ability to precisely tune desired signals at near-oscillation finally allowed me to log Tahiti-738 kHz from my southwestern-Ontario location (after years of trying) one recent morning. Around 0830 UTC, I had listened to WIAC-Puerto Rico on 740 kHz, noting a familiar 2 kHz het caused by a carrier on 738 kHz. I had audio there only once or twice that late before (although Spain had appeared on 738 kHz as late as 0700+). A signal, sometimes as late as 0900+ had to be Tahiti. Bits of French and music bridges surfaced around 0845. A quick check with both the DA-5 and 1 meter loop allowed me to hear carriers in SSB, but no audio. With the Kiwa connected, I alternated between the Icom's dual VFOs where I had entered both RFO frequencies, 738 kHz and 11826.8 kHz (miraculously usable!). By 0852 the two signals were clearly the same! Typically, modulation level was poor relative to signal strength on both channels. Absurd as it sounds, WIAC which is itself a reasonable piece of DX, slopped RFO's 738 kHz signal. I nulled WIAC at some expense to the RFO signal. However, the Kiwa's extreme selectivity and sensitivity near the point of oscillation, and the ability to precisely fine-tune it, allowed me to peak RFO's lower 738 kHz sideband. I don't count hets or carriers as logs and so I owe this audible one to the Kiwa.

FREQUENCY	CALL	KIWA	DA-5
560	WHND	S5+	S3+
560	CFOS	S9 +20db	< S7
630	CFCO	S9 +20db	< S7
760	WJR	S9 +20db	S7 to S9
1010	CFRB	S9 +40db	S9 +
1460	CJOY	S9 +40db	< S9
1575	Spain-low power	S3+	only carrier heard w/SSB
1611	Vatican (Santa Maria de Galeria)	S5+	barely audible

Informal comparison of selected signals: RF gain at maximum on the DA-5, and RF gain/regeneration levels set for peak results with the Kiwa.

NITPICKINGS AND REBUTTALS

The Kiwa has been described by some as "monstrously huge". That makes me chuckle. A one meter loop is huge! Try tilting and aiming that smoothly. The Kiwa is heavy, larger than ferrite loop antennas, but hardly monstrous. Weight, size, and layout are optimum for effective operation; tilt and aim are easily adjusted (no need to grab at little elements or knobs.) The separate control surface with a 5 inch square panel has conveniently-sized and well-spaced knobs for tuning, RF-gain and regeneration. Their position on the control surface allows all operating adjustments at the receiver, save aim and tilt. Lack of other controls on the antenna surface allowed the tilt mechanism to be optimally designed with convenient sized control knob and large tilt angle scale.

I don't recommend using the Kiwa with a portable receiver like a GE Superadio. Such receivers are housed in plastic cases and the internal ferrite loop may offset the Kiwa's nulling/aiming capabilities. Portable receivers are also prone to overload from something as powerful as the Kiwa. I read a complaint on the FIDO Shortwave Echo about the Kiwa "overloading a Sangean-803A". The same complainant will attach a 200 foot longwire to the little Sangean and boast how it is now possible to daily hear The BBC on mediumwave. The Kiwa can overload even a receiver with a good front-end but not in the hands of a knowledgeable user. The trick always, is to use minimum RF gain and maximum usable regeneration. With too much RF-gain, the connected receiver will suffer front-end overload. Too much regenerating causes oscillation and the Kiwa may transmit minor QRM to nearby radios. It is probably less interference than from nearby TV oscillators but will overload the receiver even further.

Another note of detraction, this one in the Ham Radio conference of CompuServe complained about the Kiwa's size, cost, and questioned why the Kiwa wasn't made electrostatic. The writer inferred that the Kiwa had poor "E-field" performance compared to the SM-2 and McKay-Dymek but did not cite any good reasons, nor examples of why he held those views. The comment reminded me of some of the "near-technical" but nonobjective discussions that one sometimes hears on CB. My experiences have been the direct opposite. In sensitivity, and weak signal performance, the Kiwa simply blows away the DA-5 (and outperforms an SM-2 as cited elsewhere here). As for "E-field" performance, in one test the DA-5 delivered only light dimmer noise from the floor above, while the Kiwa gave me ZLS on 526 kHz. You have to learn to use it, but it works, believe me!

REAL PROBLEMS

Instability and drifting isn't usually a problem in the Kiwa after it warms up. It will wander during the first half-hour or so. At times it may detune slightly as electrical devices turn on or off and it may even loose its null for the same reasons. The manual warns about this but when I first used mine, it really drifted off-frequency and would sometimes break into oscillation for no reason. When I powered it with an RV battery, the instability disappeared. I traced the problem to my AC source which according to volmeter readings fluctuated from 114.3 to 122.7 volts, especially after mid-evenings when I was doing most of my DXing. Craig offered to replace the control surface but suggested I first try a stable AC source like my computer battery backup system. It cured the problem. Even though the fault lies in my AC source (and is not the result of poor power supply design in the Kiwa) this may pose a problem to users who live in areas where AC service is unstable.

Harold Sellers transported his antenna on its side in the trunk of his car while travelling to the ODXA 1994 Bolton DXpedition. The Kiwa's wire loops unraveled after slipping off the form and he had to rewind them. On my Kiwa, the windings are tight and seated in deeply-machined grooves on the form surface. The wire loops on older Kiwas may not be as tight-wound as on newer ones. Craig suggests carefully dabbing epoxy across the windings near the antenna tilt axes, where the epoxy least affects the loop's appearance.

My postscript to this section on complaints is the critically sensitive tuning in the top end of the band. More important is the awkward position of the RF attenuator device inside the antenna hoop. However, I can live with both.

FINAL COMMENTS

Bill Bowers commented on my draft article, *"...I agree with the conclusions. It is the best, by far, commercially available loop!"* Kiwa products enjoy excellent reputations and The Kiwa Mediumwave Loop is no exception. This reputation is no accident. Instead it's the result of careful research, good design and excellent engineering. According to Siegenthaler, about 200 have been delivered at time of this writing (March 1994). Demand continues despite its fairly high cost which ranges between $320.00 to $330.00 (US) plus shipping, depending on the source. In Canada, brokerage, GST, and exchange add to the cost. It is pricey but you get what you pay for!

It is evident from this review that I am pleased by my Kiwa's performance. Aside from doing comparisons, I've used only the Kiwa since I got it. Was it worth the money? I've exhausted the DX potential of my existing equipment. Definitely! In fact, I am considering the purchase of a second Kiwa for remote use. It is a piece of gear for the serious mediumwave DXer. State-of-art performance and operating features don't come cheap but give a decided edge to the user who is willing to learn how to extract all the performance this unit is capable of. My benchmarks were proven performers but *the Kiwa is simply better, and beats anything I've ever used, hands-down!* As conditions continue to improve, I'll be ready with my Kiwa (or Kiwas) and you know, I might even finally hear Brazil.

KIWA LOOP SPECIFICATIONS

Tuning Range: 30-1700 kHz Continuous tuning using main and fine tuning controls.

Regeneration: Adjustable bandwidth control provides a 70-75% reduction in bandwidth from minimum position.

-6 db Bandwidth: (with regeneration control at minimum) The maximum -6db bandwidth occurs at 1700 kHz which -typically measures +/- 7.5 kHz (15 kHz). The -6db bandwidth narrows as the frequency decreases. At 650 kHz the -6db bandwidth is 6 kHz.

Attenuator: Adjustable from full sensitivity to an off condition.

Outputs: Two independent outputs capable of simultaneously driving two 50 ohm receiver inputs via PL-259 connectors.

Power source: 12 VAC @ 300 ma. wall-plug transformer or 13.7 VDC battery source for field operation (typical current drain 50 ma.).

Dimensions: Overall -height 17 in (43 cm), - width 18 in (46 cm). Antenna coil size - 12.75 in (32.5 cm) in diameter.

Total weight: Antenna, control surface and power transformer - 14 pounds or 6.3 Kg.

VERY LARGE FERRITE LOOPS

Bill Bowers and John Bryant

Over the years, there have been several medium wave and /or Tropical Band ferrite bar loops on the market. These have included the Palomar loop, the Space Magnet, the Dymek DA-9, the Radio West 22" and the Quantum Loop. Of these, only the Dymek and Palomar continue in production today. After testing most of these loops several years ago, it was clear that the loops with the larger ferrite bars gave noticeably better performance than the others, especially when used in a low noise environment. This observation coupled with the "normal" DXers' craving for ever more effective antennas prompted us to investigate loops with much larger ferrite bars.

The Radio West Antenna, with it's 22" bar assembly, was the leader among the commercial loops we tested. Unfortunately, it is no longer available. The next largest commercially available ferrite bar was the 12" x 3/4" rod used in the Dymek DA-9 antenna. This antenna gave very satisfactory performance and was used as a reference for comparison with the much larger loops that we designed and constructed during for this project.

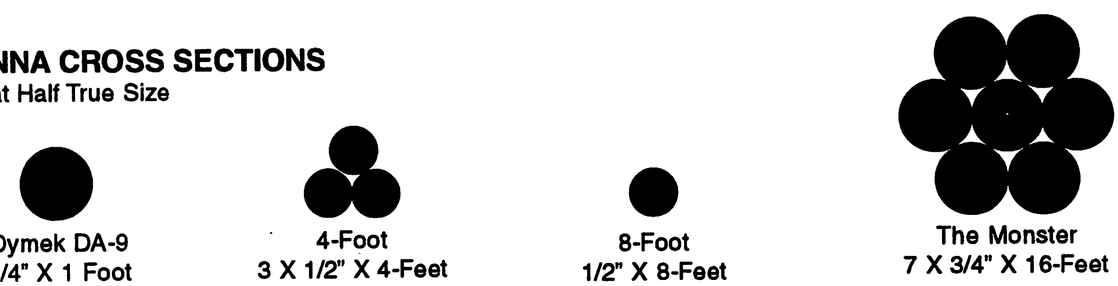
THE ANTENNAS

After a good bit of reading and calculating, we determined that the largest ferrite bar that we could build would be a 16 foot long composite bar constructed from approximately 112 bars of Amidon Type 33 ferrite material, each measuring 12" x 3/4" and arranged in a bundle with a 7 bar cross section. This undertaking turned into a major construction project since the ferrite rods alone weighed well over 100 lbs. Our finished product, now known as "The Monster" rotates and tilts just like most smaller ferrite rod loops. The Monster's frame is constructed primarily of wood, aluminum, and plastic. As design work on The Monster proceeded and its size and weight became obvious, we decided to construct an intermediate size loop as a prototype. This second antenna is the one noted as the 4-foot bar in the discussion below. It was constructed of a bundle of three Type 33 material bars each of 1/2" diameter. Later, as we began to suspect that sharpness and depth of nulls was directly proportional to the slimness of the ferrite bar, we constructed an antenna 1/2" in diameter and 8-foot long. It is also evaluated below.

With the exception of the 8-foot antenna, each antenna was constructed of Amidon Type 33 material which was readily available to us. Type 33 material is most effective in the LF and MW frequencies. For this reason, all of our tests were performed at medium wave frequencies. The rods in the 8-foot loop were Type 43 material which is useful to higher frequencies. Both types of bars had a permeibility of 850.

ANTENNA CROSS SECTIONS

Shown at Half True Size



ROD ASSEMBLY

The loops that were tested contained ferrite core assemblies as listed below:

ANTENNA	CROSS SECTION	AREA	EFFECTIVE DIAMETER	LENGTH	L/D	MATERIAL
Dymek DA-9	1 X 3/4"	0.44	0.75	12"	16	A-1
4-Foot	3 X 1/2"	0.59	0.87	48"	55	A-2
8-Foot	1 X 1/2"	0.2	0.5	96"	192	N
Monster	7 X 3/4"	5.25	2	192"	96	A-1

A-1: AMIDON R33-075-1200 A-2: AMIDON R33-050-750 N: NEBRASKA SURPLUS SALES, CAT. #ICH-FEROD-8

COILS

The coils on each of the larger loops were wound using 50x36 AWG Litz wire, since we had a generous supply of this wire available. Actually a 36 AWG wire is too large to afford a significant improvement in performance over a coil wound with normal solid wire. Litz wire of 42 AWG or 44 AWG strand is far more suitable for this application, but was not available.

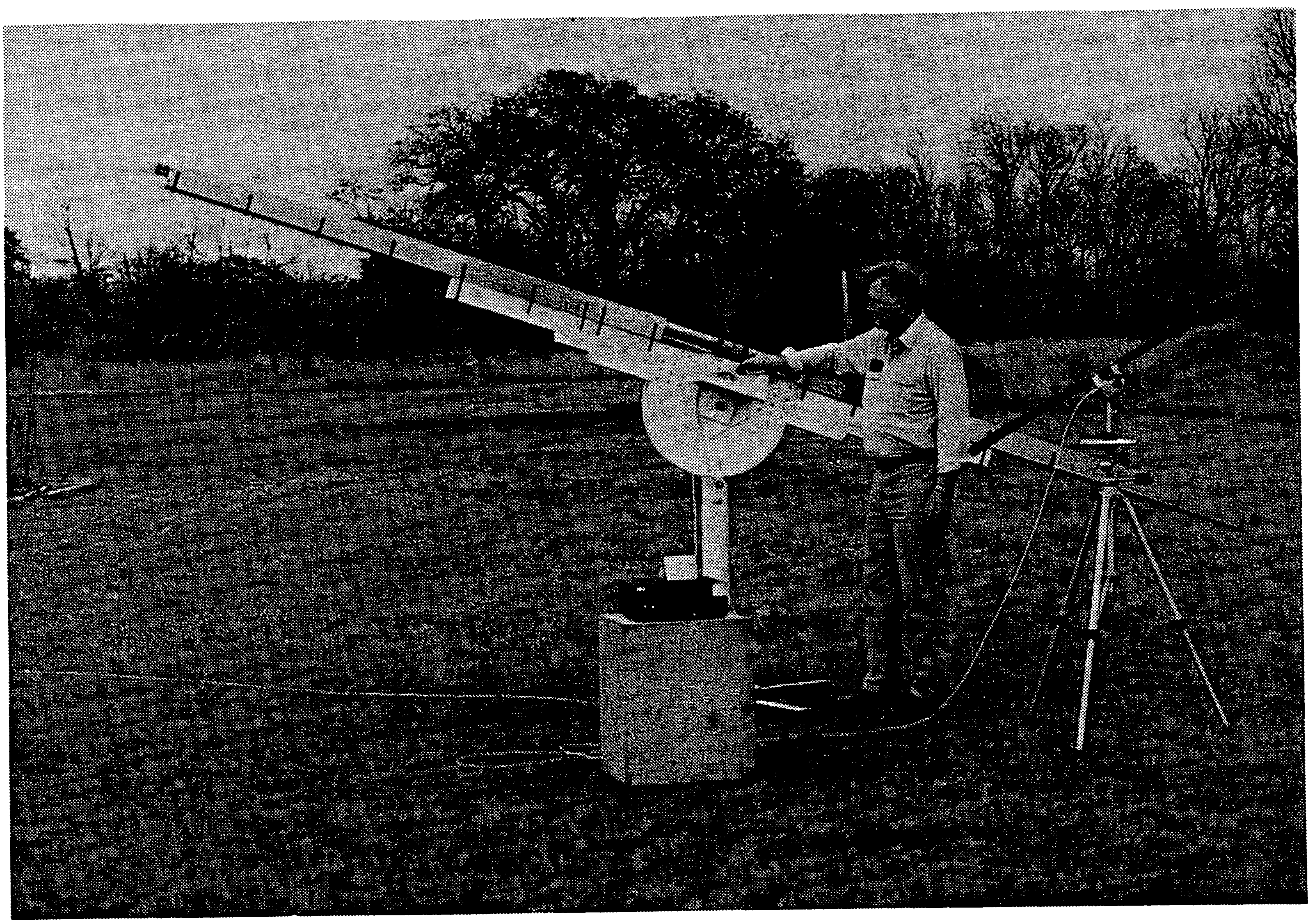
The number of turns in the coil of each antenna was adjusted to give an inductance as close to 0.25 mh as possible. This inductance made it possible to tune down to 530 kHz. with a standard 365 pf variable condenser and up to about 1600 kHz. with the smaller antenna/coil assemblies. However, the distributed capacity of the coils on the larger antennas made it difficult to reach to quite 1600 kHz. with the 365 pf variable capacitor we were using. Therefore, all of our high frequency tests were performed at 1490 kHz.

During the early phase of this project, we conducted experiments on the length of the pick-up coil. We tested coils wound with extremely wide spacing, intermediate spacing and close wound. No significant improvements were noted for any particular coil winding configuration. Our final coils were wound in the center of the rod assemblies with a gap between each turn approximating one wire diameter.

TEST ARRANGEMENT

During testing, the four antennas were not mounted as shown in the photograph. For actual performance testing, the antennas were positioned about 50 feet apart in a semi-circle around the receiver. During those tests, the whole set up was located in the open prairie several hundred feet from any structure.

To equalize the measurements of the signal output of each antenna, a single preamp from a Radio West 22" antenna was used. It was moved from antenna to antenna as the tests were made. The coax from the preamp was connected to a precision RF 20 db step attentuator and then to a Drake R-8 receiver. The R-8 receiver was modified by replacing the built-in S-meter with a large 50 microamp meter connected to the receiver by a 50 foot extension cord.



Co-author Bill Bowers with the Monster and the Four-Footer.

This made it possible to move the S-meter to each antenna location to measure the signal output at the maximum and null position of the antenna. Because of the logrythmic nature of an S-meter circuit, the step attenuator was used to keep the meter in the most sensitive range. Before conducting the final performance tests, the S-meter and the step attenuator were calibrated with known R.F. signals. For these measurements and for the tests, the R-8 was set at A.M., Fast AGC, and 2.3 kHz IF filter.

TEST SIGNALS

We had a number of different ideas for sources to be used as test signals in the final antenna tests. Deciding which type of signal to use in the performance tests was very difficult because we wanted to obtain both the most accurate and the most relevant results. Because of the constantly changing medium wave propagation conditions in the evening, signals from distant stations proved to vary far too much due to normal fading to be used for accurate comparative measurements. The final performance tests were run using signals from three near-by low power stations. To assure maximum accuracy, the test measurements were made between 10:00 AM and 3:30 PM when the signals from these stations were the most constant. Since these signals were virtually 100 percent groundwave, there was no need to tilt our antennas during the tests; this simplified matters considerably.

FREQ.	POWER	CALL LETTERS	LOCATION	DISTANCE
640	1 KW	WWLS	Moore, OK	48 Mi.
890	1 KW	KBYE	OKC, OK	48 Mi.
1490	1 KW	KOKC	Gutherie, OK	40 Mi.

Tests were conducted by tuning the receiver to one of the test stations and then connecting the preamp to the first antenna. We recorded signal strength readings at the maximum signal and then at the deepest null. The preamp was then moved to each of the other antennas and the procedure repeated. When the signal strength was so high that it deflected the S-meter past 3/4 scale, the step attentuator was used to bring it back to a more sensitive range.

RESULTS

The table below records the maximum signal strength measured in microvolts from the preamp when it was connected to each antenna. The signal strengths shown are an average of five readings taken over 3 days.

Maximum Signals in Microvolts

ANTENNA	640 KHz	890 KHz	1490 KHz
Dymek DA-9	1100	250	200
4-Foot	2100	550	400
8-Foot	1900	500	400
Monster	5200	1300	1000

The results were somewhat as expected, but were also in many ways disappointing. The disappointment was that we expected the output of The Monster to be much greater. With the cross-sectional area of The Monster nearly 10 times larger than that of the 4-footer (5.25 square inches vs. 0.59 square inches) and the L/D ratio being almost twice as much, we expected that the output of The Monster would be at least 10 times that of the 4-footer.

Since both antennas were constructed using the same Amidon Type 33 material, initially, there was no clear explanation for the lower output of The Monster. One factor that was not fully investigated was the possibility that the preamp input impedance may have loaded the higher Q Monster coil more than that of the 4-footer. Also, the preamp may have been over-loaded or non-linear when dealing with the stronger signals coming from the Monster. We were puzzled by these results during the tests but did not identify these potential causes until after testing was completed.

All of the antenna outputs dropped at the high frequency end of the spectrum. This is contrary to classic antenna theory and is probably due to losses inherent in the Type 33 ferrite material. Amidon suggests that Type 33 only be used up to about 1000 kHz. This signal drop-off may have also been due to the greater propagational losses inherent in the higher frequencies. This should have been checked with an air core loop and was not.

NULLS

All DX'ers know the advantages of using a moveable antenna which generates deep nulls and can therefore eliminate strong interfering stations. In our testing, the nulls were carefully and repetitively measured. It is important to note however, that a simple list of the minimum micro-volt signals at a null would have been very misleading. The maximum signal generated by that antenna on that station must also be considered in comparison with the minimum signal from that same station and antenna. For this reason, the table below lists the ratio of maximum signal/minimum signal. This approach means the larger the number listed below, the deeper the null achieved.

NULLING ABILITY: MAX. SIGNAL/MIN. SIGNAL

ANTENNA	L/D	640 KHz	890 KHz	1490 KHz
Dymek DA-9	16	40 to 1	32 to 1	28 to 1
4-Foot	55	81 to 1	66 to 1	57 to 1
8-Foot	192	95 to 1	82 to 1	67 to 1
Monster	96	90 to 1	82 to 1	59 to 1

The result of these tests clearly indicate that the deepest nulls are obtained by the antenna with the highest L/D ratio (or the most "slimness") of the ferrite rod assembly. However, there is more to the null story that the null numbers would indicate. In the case of the Dymek antenna, nulls look respectable numerically, but when a deep null was achieved, there was usually nothing but noise remaining. After all, these tests were being run in the middle of the day. However, with all the larger antennas, there were always one or more other stations audible in the same null during these same mid-day tests! This was particularly true when using The Monster.

VARIOUS CONCLUSIONS

GAIN: It is obvious that we confirmed the supposition that raw gain goes up with the size of the ferrite bar used. However, as we have noted, the gain increase obtained with The Monster was not as much as we expected. We will be pursuing this issue further.

"EFFECTIVE " or "USEFUL" GAIN: A general attitude in antenna design is that after a certain point, antenna gain is useless; and may even be counter-productive by causing receiver overload. The general idea is that if the antenna has enough gain so that the "noise of the band" is heard, every signal peaking above that noise floor will also be heard. The saying is that "Everyone in the boat goes up with the rising tide."

Although the above is certainly true, you must first be sure that you are actually hearing band noise. The Dymek antenna is a beautifully built commercial grade antenna based on a 12" x 3/4" rod. It has produced prodigious results in the hands of astute DXers. However, the difference in "hearability" or "effective gain" between the Dymek antenna and the 4-foot bar antenna was very striking! Signals that were weak and noisy with the Dymek became armchair copy with far less noise with the 4-foot bar. As we noted, when nulling strong stations with each of these antennas, we also noted significant differences. During these daytime tests, we often noted an "open channel" under the dominant signals with the Dymek and yet found one or more copyable signals in the same null with the 4-foot bar. This was even more apparent, of course, using The Monster.

DEEP NULLS

We were initially surprised that the nulls of The Monster and the 4-foot bar were similar. Eventually, we came to understand that the sharpness and depth of the nulls are somewhat proportional to the slimness of the bar. The 8-foot by 1/2" bar antenna was constructed primarily to test this hypothesis. Note that the slimness ratio of the 8-foot x 1/2" bar was 192, as compared to 55 for The Monster. As illustrated in the null figures, this very long 1/2" diameter antenna did, in fact, produce the deepest nulls.

OTHER LOOPS

This project was not designed to evaluate commercially available loops. We did not do so. However, since there is considerable interest in the performance of these antennas as compared to the larger ones that we have tested, the following general observations are reasonably accurate.

THE RADIO WEST 22" LOOP: The performance of the Radio West 22" antenna tracked that of the 4-foot antenna, but with somewhat less sensitivity and depth of nulls. Like the other ferrite loops at the null position, there were usually one or more signals audible during our daytime tests where the Dymek DA-9 often only produced what we thought of as "band noise" before we knew any better. The difference in performance between the Radio West 22" bar and the 4-footer was significant enough for any owners of these fine antennas to seriously consider adding length to their Radio West bars.

THE KIWA AIR CORE LOOP: The Kiwa Air Core loop became available after our testing program of commercially available loops was completed. Because of the wide interest in this innovative antenna, a few preliminary comparative tests were performed. First of all, we must mention that the Kiwa Loop has set a new standard for both beauty and professional quality mechanical design. The regeneration control of the amplifier is quite effective in providing a great deal of selectivity. It does, however, make the operation of the Kiwa loop somewhat more complex than the other antennas. If you are looking for a station on a specific frequency, the regeneration control can be peaked to give very narrow band width and maximum sensitivity. If, on the other hand, wandering around the band is in order, the regeneration must be decreased to a minimum and some retuning is necessary.

Compared with the 4-foot bar, the Kiwa loop gave noticeably BETTER performance above 1.2 MHz.! On the lower portions of the band, the 4-foot bar gave somewhat better signal strength and nulls. We were pleasantly surprised that any 1-foot diameter air core loop could 'keep up with' a very large ferrite antenna.

It is not fair to draw any final conclusions on these latter general comments. More detailed tests comparing an optimized 4-foot ferrite bar antenna with the Kiwa loop will be conducted and reported in the medium wave press.

THE BOTTOM LINE

After many configurations and tests, it is clear that bigger is better, but in this case, not all that much better. We will continue to experiment with The Monster for some time to come. Bill is determined to prove that classical theory is correct, even at this giant, off-the-design-chart, scale. John has plans to mount a John Deere tractor seat on the vertical column of the Monster so that we can ride it! We could control the thing with our feet and spin and point it just like a WWII antiaircraft gun! On the other hand, a 16 foot bar antenna that requires half the local high school football team to move around the yard probably is well beyond the law of diminishing returns. Whether one can afford the ferrite or not, The Monster is just not a practical DXer's antenna.

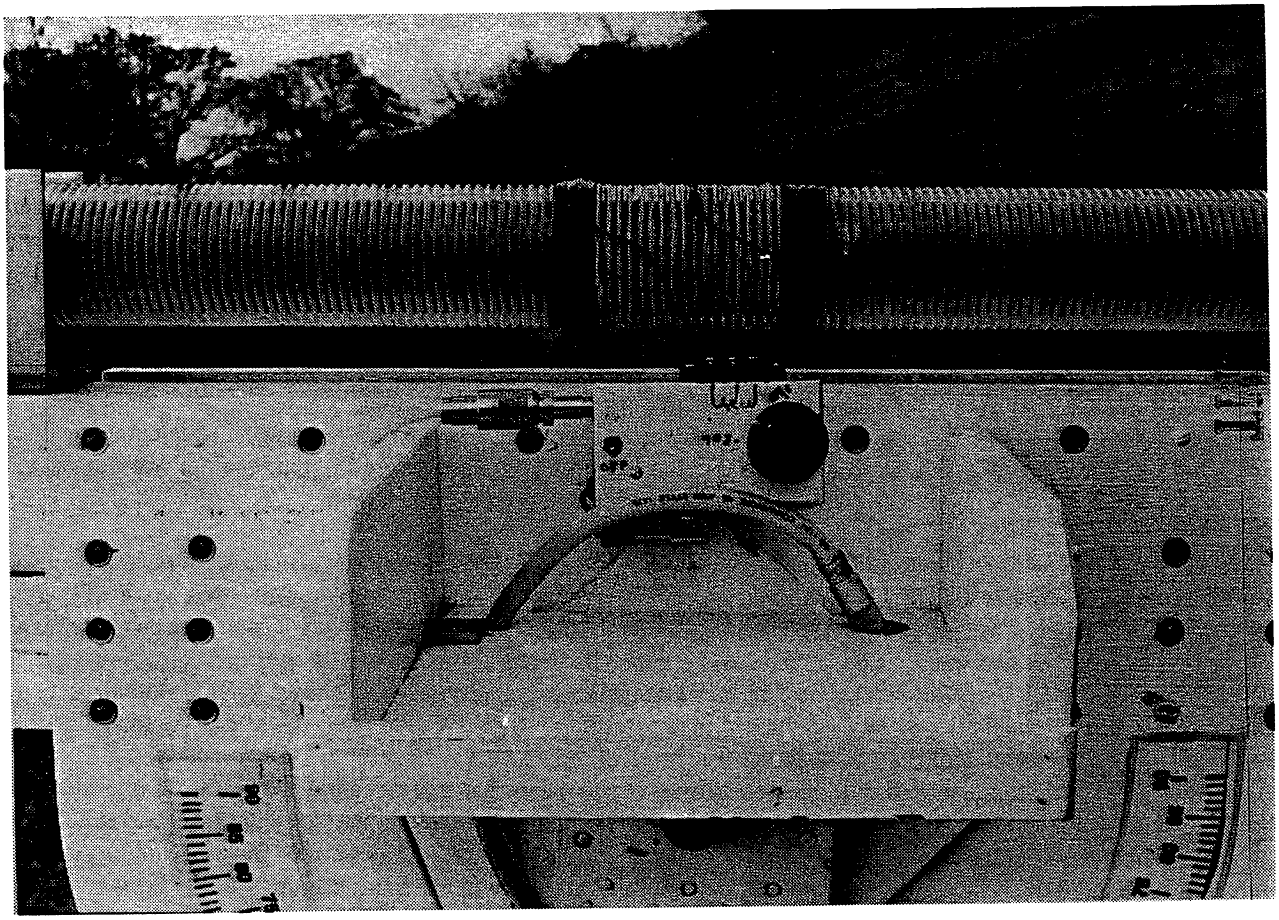
However, we are both fascinated with the capabilities of the 4-foot bar that we initially built as an intermediate prototype. It generates very good nulls, has very good gain and is a manageable size in the shack or on DXpedition. John has done some informal comparisons between the 4-footer and his wagon wheel array of 450' Beverage antennas. The bar may not have quite the same gain in every case, but it is most certainly in the same league. We like the 4-footer so well that we now each have one in our shacks. We also hope to construct a 4-footer of ferrite of the correct type to work well on the Tropical Bands. Such an antenna would be able to null at least some local noise while possibly having very good gain. There is also a very good possibility that a ferrite bar Tropical Band antenna would be inherently quieter than many more conventional antennas.

AUTHORS' END NOTES:

Cost: The Amidon 7.5" x .5" Type 33 rods used on our first 4-footer now cost $20.00 each (AMIDON phone: 310-763-5770). A less expensive alternative would be to use their 4" x .5" rods at $6.00 each. The Amidon 12" x .75" Type 33 rods cost $20.00 each a number of years ago but are not now available. Amidon is willing to fill pre-paid special orders of the .75" rods for $75.00 each with a minimum of 10 rods.

A better alternative for rods may be the Nebraska Surplus Sales (1502 Jones Street, Omaha, NE, 68102-3112. Phone: 402-346-4750). Their 8" x .5" Type 43 rods cost from $9.00 to $12.00 based on quantity. The Type 43 material works quite well at both MW and Tropical Band frequencies.

4-Footer Construction Notes: Our design for the 4-footer consists of 18 eight inch long Nebraska Surplus rods bundled in a 3 rod cross section as shown early in this article. It is extremely important to stagger the ends (joints) of the rods. It is also important to bind the rods together so that no air gap developes between the ends of individual rods. The coil should consist of from 20 to 24 center-tapped turns, depending on the tuning capacitor available. We plan to publish a fully detailed construction article as soon as development is complete.



Central portion of the Monster showing coil and preamplifier shelf.

IMPEDANCE MATCHING DEVICES
For Simple Wire Antennas

John Bryant and Bill Bowers

In recent years, it has become standard practice to use 52 ohm coaxial cable lead-ins for almost all wire receiving antennas used by DXers. This trend is no doubt driven by the rapid increase in RF interference-producing devices in almost everyone's home and neighborhood. With simple end fed antennas, standard practice has been to connect the center conductor of the coaxial cable to the antenna wire and leave the braid/shielding unconnected at the top. The braid of the coax then shields the center cable; RF interference is drawn off the braid at the receiver and goes to ground. This strategy is very successful in reducing near-field noise.

As this practice developed, many DXers have been concerned about the potential signal loss at the junction between the main antenna and the coaxial cable. Simple wire antennas are inherently high impedance devices and the coaxial cable is , of course, quite low impedance. Many DXers wondered if this obvious mis-match (and thus, signal loss) really made any difference at all. The conventional wisdom has been that it does not. The reasoning is that if the antenna system is well matched to the receiver AT THE RECEIVER, all is okay. The reasoning continues that if an antenna has enough gain so that you can clearly hear 'band' or atmospheric hoise, then any additional gain is really unnecessary; you will hear any signal which shows above the general band noise.

Several factors led us to question this wisdom:

A) In DXing, we are often trying to hear very weak signals right at the noise floor of our receivers. It seems wrong to willingly accept a loss of gain through a severe antenna/lead-in mis-match when it can easily be corrected.

B) There are many times that even the Tropical Bands are extraordinarily quiet. Under those conditions, reception may very well be limited by circuit noise in the receiver. Under these conditions, a higher gain antenna would be very useful.

C) At least two devices intended for use between coax lead-in and simple wire antennas have been marketed in the past two years. It seemed reasonable to test their effectiveness.

ANTENNA IMPEDANCE

A single straight run of antenna wire, end fed, is generally considered to be a high impedance device, usually measuring 400 to 700 ohms. However, it is very important to note that impedance naturally varies with frequency and antenna length. The end impedance of an end-fed antenna is related to its electrical wave length. There is always high impedance at the far end of the antenna wire. Antennas which are one-quarter wave length (or odd multiples of 1/4 wave length) present LOW impedance to the receiver. An antenna of less than 1/4 wave length, or 1/2 wave length (or its multiples) presents HIGH impedance the receiver. So, if an impedance matching device is used to significantly lower the impedance of the antenna (say a 10 to 1 device to reduce 600 ohms to 60 ohms) there will be frequencies where the impedance will be transformed to too low a value.

Radio amateurs solve this problem by operating over a restricted frequency range or its multiples and designing appropriate length antennas. SW and MW DXers are in a much more difficult position since the frequency ranges of their interests are so much broader. They are faced with either not using impedance matching at the antenna/lead-in interface and having a severe impedance mis-match at most frequencies, or, using an impedance matching transformer and dropping the impedance too much near those frequencies where the wire represents 1/4, 3/4, 5/4... wave length. The only complete solution to this problem would be the have a remotely controlled variable antenna tuner at the junction between the antenna and the coax lead-in. Our concern in this project was to determine whether an impedance matching device was actually beneficial.

TEST SET-UP

Over the past two years, we have done a good bit of comparison testing of antennas. The results were published in Proceedings 1992-93 ("Active Antennas") and in this edition ("Very Large Ferrite Loops"). The testing apparatus employs mechanically and electrically identical coaxial cable lead-ins, low-loss coax switches and an ICOM R-9000 receiver. This receiver is particularly useful because its spectrum display of received signals is marked off with 10 dB signal level increments. Most of our measurements were made using a combination of the spectrum display and the R-9000's large mechanical/electrical S-meter.

We did several different runs of the tests presented below. The first runs were made using two identical 150' antennas about 20' apart. Although the data generally appeared to be quite acceptable, there were a few anomalies which might been due to interaction between the two antennas. The final tests presented below were made using a single wire antenna. Two identical coax lead-ins were run to the antenna. At the antenna, two 12v relays were used; they were wired so that one lead-in was active while the other was grounded. Thus, we could instantaneously compare signal levels between a 'bare' lead-in and one with an impedance matcher in-line between the antenna and the lead-in.

THE IMPEDANCE MATCHERS

The ICE Model 180 Antenna Receive-Only Matching Assembly
Industrial Communications Ltd. PO Box 18495, Indianapolis, IN 46218-0495. 1-800-423-2666. Cost $32.00 + S/H

The ICE Matcher is an extraordinarily well made device enclosed in an RF-tight cast aluminum box using stainless steel hardware. It is based on a ferrite-cored transformer tapped so that impedance transformation is set for 300,450 or 600 ohm input from the antenna. Output ia a standard 50-239 'coax' connection. The device is intended to be pole or mast mounted at the receiver end of the wire antenna. Unlike any other device tested, the ICE model 180 includes a resistor and neon bulb arrangement to bleed off harmful static electricity from the antenna. Further, this matcher contains a capacitor in series with the signal so that low voltage DC may be run up the coax to control switches, etc. There is also an external grounding lug, if grounding the transformer at the antenna is desired. Like other products from Industrial Communications Engineers, this device is very well made using excellent components and is fairly priced.

The Magnetic Longwire Balun
RF Systems/Doevon Electronics, The Netherlands. Obtained from Universal Radio, Reynoldsburg, OH 1-800-431-3939 Cost: $59.95 + $3.00 S/H

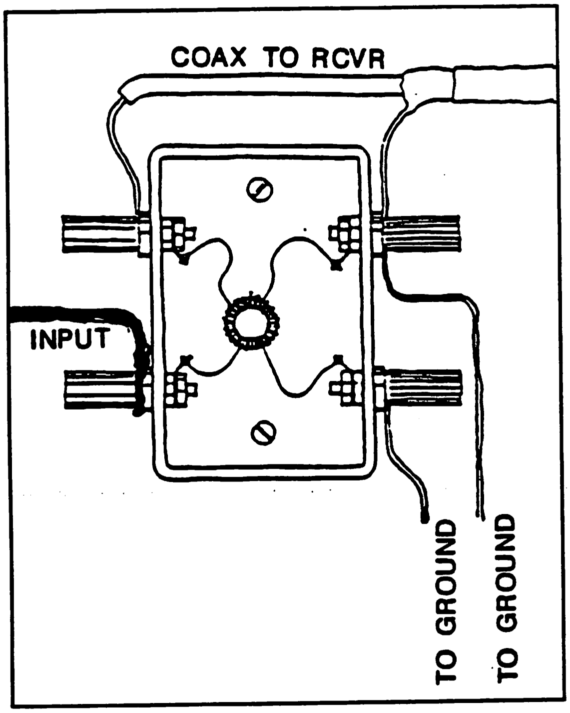
The Magnetic Longwire Balun is completely encapsulated in a cylindrical plastic housing with a binding post on one end and a S0-239 coax connector on the other. There is no external grounding stud and the impedance transformation ratio (about 9 or 10 to 1) is not user selectable. The unit is intended to hang from the antenna wire, with the lead-in hanging below the balun itself.

To quote from the manufacturer's 4-page pamphlet....

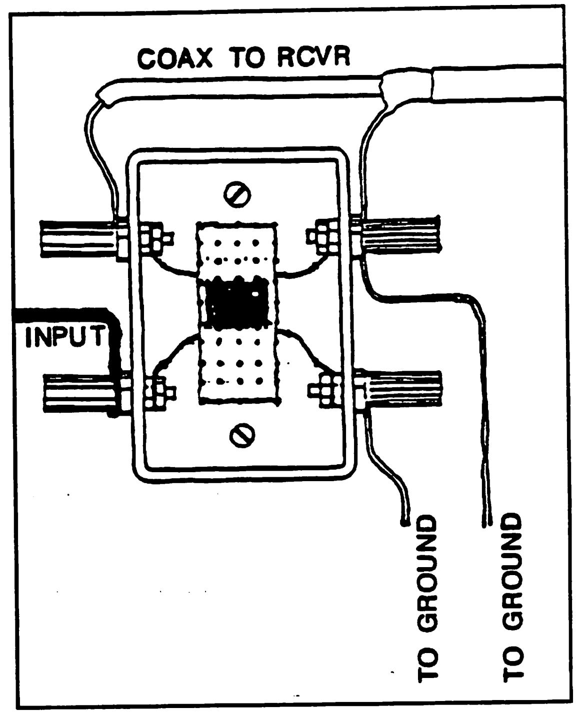
> *"The Magnetic Longwire Balun is a compact, weather-proof matching unit. It consists of a special patented transformer with magnetic field coupling. The impedance transformation ratio changes with frequency. The end result is a simple device which you connect to the end of a longwire antenna (or in the middle of the "T" antenna). The other end of the unit has an SO-239 socket designed to match 50 ohm coaxial feeder cable. The advantages are immediate. The lead-in cable is immune from local man-made interference, and doesn't have to be isolated from its supports."*

This is but the first of several places where the manufacturer makes the claim that the 'transformation ratio changes with frequency.' At the end of the tests, the authors cut the Magnetic Balun apart. The housing is rather cleverly assembled from a short section of plastic plumbing pipe and two end caps. Inside the case we found what appears to be a normal ferrite-based transformer further encapsulated in plastic 'potting' material. Rather than cutting further, Bill put the device on his sophisticated test bench. Sure enough, DX Systems' claim that 'transformation ratios change with frequency' is simply NOT TRUE and is, at best, very misleading advertising and a clear misrepresentation. The manufacturer also states that this "balun" provides "static protection" This is also not true in the accepted technical sense of the term since there is no external grounding stud on the unit. The only path for static charges to take to ground is down the coaxial shield to the receiver chassis. You should also note that the parts and material costs of this device, if purchased RETAIL on the open market, cannot exceed $6.00, less than 1/10th of the purchase price. Finally, this device is NOT a balun. The normally accepted definition of "balun" is a transformer which converts from balanced to unbalanced configuration. This unit is an impedance matching device designed to attach an unbalanced feed line to an unbalanced antenna. Although the foregoing description is harsh, the "Magnetic Longwire Balun" is misrepresented by the manufacturer and is VERY unfairly priced.

Hall-Patch Impedance Matcher



"Mini-Circuit" Impedance Matcher



The Hall-Patch Impedance Matcher

(Home-brew device. Details were first published in Proceedings 1988. See sketch above.)

This matcher uses a torroidal (doughnut-shaped) ferrite core which is available from Amidon Associates, Dominguez Hills, CA. Phone: 310-763-5770. Note that ferrite torroids are produced with differing frequency characteristics; the one used was a FT-50-43 and the design was selected to optimize performance MW and the Tropical Bands. Binding posts are shown in the drawing above for the connection. However, most DXers prefer to install an SO-239 connector.

The 'Mini-Circuit' Impedance Matcher

(Home-brew device. Details were first published in Proceedings 1992-93. See sketch above.)

The 'Mini-Circuit' balun is quite similar to the other home-brew impedance device above. However, in this latter case, the impedance transforming device is a RF transformer chip (similar in appearance to an integrated circuit chip) manufactured by RF Mini-Circuits, P.O. Box 350166, Brooklyn, NY 11235-0003. Phone: 718-934-4500. Inside the chip is a very small transformer wound on a ferrite bead the size of a large match head. Like the cores from Amidon, the RF Mini-Circuit transformers must be selected for the frequency range of interest. The tested unit is based on a 9 to 1 ratio transformer (T9-1) whose RF range is .15-200 MHz.

CONCLUSIONS AND RECOMMENDATIONS–SHORTWAVE

The accompanying chart records our comparison of signal strengths (in decibels) between the 150' test antenna with and without the impedance matcher in place. As you can see, both of the commercially produced impedance matchers worked well on shortwave. They were particularly effective on the Tropical Bands and on the higher frequency International Bands. The dip in performance of all the matchers at the 5 to 8 MHz frequencies is probably due to the 150' antenna being at lower impedance over those frequencies. The Mini-Circuit based 'home-brew matcher also performed relatively well on shortwave, showing no losses at any frequency and good gain on the Tropical Bands. The other home-brew matcher based on the hand-wound torroid also performed very well on 90 and 120 meters. However, significant losses were noted at and above 5 MHz These losses were almost certainly due to the core material selected.

Signal Strength Comparison in Decibels

FREQ.	I.C.E 600 ohm	I.C.E 300 ohm	Magnetic BALUN	Torroid BALUN	Mini-Circuits
2.5 MHz WWV	10	7	12	6	10
3.33 MHz CHU	10	5	10	10	7
5.0 MHz WWV	5	5	3	-6	0
7.335 MHz CHU	0	2	0	-10	0
10.0 MHz WWV	3	5	0	-2	2
15.0 MHz WWV	4	6	5	0	4

If you are interested in purchasing a ready-made matcher, there is no choice: buy the ICE unit. At the 600 ohm setting, it performed about identically with the "Magnetic Balun". It offers full static protection, a choice of grounding configuration and also allows a choice of impedance ratios to meet individual preferences. Note, however, the comment related to the blocking capacitor which is found in the Medium Wave recommendations to follow. If "home-brewing" is your choice, it is hard to go wrong with the Mini-Circuit based design. If you would like to construct a matcher based on ferrite torroids, we suggest that you select the core material with particular attention to the intended frequency range. With either home-brew design, we suggest adding full static discharge protection similar to that used in the ICE unit. This can be achieved by connecting a small neon bulb (Radio Shack #272-100) from the signal path to ground.

150 Ft. Wire Antenna

FREQ.	I.C.E. 600 ohm	I.C.E. 300 ohm	Magnetic BALUN	Torroid BALUN	Mini-Circuits
580 kHz WIBW	7	3	8	9	8
780 kHz KSPI	11	6	9	9	8
890 kHz KBYE	10	8	5	7	5
1000 kHz KTOK	5	8	3	2	2
1140 kHz KPRW	0	3	0	-4	-3
1220 kHz KTLV	-3	0	-2	-8	-7
1340 kHz KXXY	-5	-5	-5	-8	-7
1490 kHz KOKC	-8	-5	-2	-2	0
1600 kHz KUSH	2	3	2	0	3

Signal loss or gain in decibels

50 Ft. Wire Antenna

FREQ.	I.C.E. 600 ohm	I.C.E. 300 ohm	Magnetic BALUN	Torroid BALUN	Mini-Circuits
580 kHz WIBW	18	3	33	33	29
780 kHz KSPI	8	4	11	11	10
890 kHz KBYE	8	6	11	13	9
1000 kHz KTOK	11	5	13	12	8
1140 kHz KPRW	15	10	12	13	10
1220 kHz KTLV	15	12	12	12	9
1340 kHz KXXY	14	10	9	11	7
1490 kHz KOKC	16	12	18	21	18
1600 kHz KUSH	12	8	12	20	13

Signal loss or gain in decibels

CONCLUSIONS AND RECOMMENDATIONS–MEDIUM WAVE

As with the shortwave tests, the accompanying charts record the differences in signal strength (in decibels) between the antenna with and without the impedance matcher being tested. Please note carefully the differences between our first test using a 150' antenna and the second one using 50' of wire! Discussing performance with the 150' wire first: The almost uniform loss pattern in the upper half of the band is due to the fact that the 150' wire was performing as a 1/4 wave antenna as discussed at the beginning of this article. Antenna impedance had dropped low enough at these frequencies that we were OVER transforming and incurring losses because the antenna plus matcher was presenting far too low impedances to the 52 ohm coax. This theoretical supposition was proved in the second medium wave tests using only 50' of wire. Antenna lengths of 100' or less always present high impedance to the lead-in at medium wave frequencies since those lengths are less than 1/4 wave length, even at the top of the medium wave band. As you can see, all matchers performed very well using the shorter antenna. SPECIAL NOTE: The blocking capacitor in the ICE unit begins to think that signals below about 600 kHz. are DC current and to block them. Unless you plan to run DC up your coax, we recommend opening the ICE box and placing a jumper across the capacitor.

Again, if you wish to purchase a ready-made matcher, the ICE unit connected at 600 ohms is the only choice. If you wish to home-brew your matchers, either a ferrite torroid of appropriate material or the Mini-Circuit chip seem to perform equally well on medium wave.

FINAL REMARKS

It seems clear that appropriately selected impedance matching devices will improve the gain of simple wire antennas. Your S-meter will go up using one of these gizmos. However, our test numbers DO NOT address the issue of effective useful gain. Were the experts right when stating "everyone in the boat goes up with the rising tide"? Our findings in this area are more subjective. However, during our tests, we DID notice a number of instances where the signal-to-noise ratio of weak signals was improved significantly. We also noticed that the 'valleys' of most rapidly fading signals were filled in by the stronger signals available using an impedance matcher.

If you are using a simple wire antenna, we strongly recommend using the appropriate impedance matcher if you wish to use coaxial cable lead-ins.

ANTENNAS FOR TROPICAL BAND DXing

Some Neglected Considerations

Tony Ward, VE3NO

Short-Wave Listeners and DXers have been somewhat slower than amateur operators to appreciate the delights of high-performance antennas– and not without good reason. For international shortwave broadcasting station powers are high and getting higher. And if coverage is a problem the chances are a major broadcaster will bring the signal to you via a local relay. Peak listening periods– breakfast, and early evening– coincide with the best band conditions. If a piece of wire out the window works well enough there seems little incentive to move to a better antenna design. Hams have different problems to solve. Many of them of course are quite content to stay with local coverage, but the hard-core ham DXers have always pushed the envelope of sophisticated antenna design in order to maintain reliable two-way contact with distant areas of interest, using far more modest power than the major broadcasters. The feeding-frenzy that results when a DX station turns up for a spin on one of the low bands in particular, provides a very public showcase for successful antenna setups, and this is a powerful incentive to improve system performance. Listening DXers have more in common with ham DXers than with SWLs. Perhaps they have a tendency to work in greater isolation from their peers than is the case for hams, but many of the lessons to be learned are the same. So please bear with the ham-radio examples, and assess the thoughts that follow in conjunction with the article by David Clark and myself on Tropical Band Propagation, elsewhere in this volume.

There are other ways than antenna improvements to increase the quality of one or two-way contact, and the pages of Proceedings document many of them; both simple and esoteric. Narrow-band transmission and reception– ssb for example– or the use of filters, make easier the detection of the faint and distant signals that are the meat and potatoes of our DXing interest. Which are the best radios; the best filters; these are the stock-in-trade of many a fine conversation between DXers. And now here come the new generation DSP's hot on the heels of het-killing notch filters! We need all these goodies of course (as our loving spouses *all* agree!), but nothing can beat improvements in antenna efficiency ahead of the receiver. For DXers the horizontal and the vertical directivity of an antenna are among its most important attributes, particularly when trying to understand the vagaries of propagation . The horizontal payoff is fairly obvious and generations of DXers at their homes– if they are lucky– or at least on DXpedition have erected arrays of travelling-wave antennas to enjoy the benefits that long wires can bring.

ARRIVAL ANGLES, DIRECTIVITY AND POLARITY

While there are many different kinds of antennas designed with special aims in mind– saving space, or low visibility for example– few of these make good DX weapons. The often extreme sensitivity of modern solid-state receiver front-ends allows surprising performance from unelaborate designs, but it should come as no surprise that there is a price to pay. Very little can beat a long piece of wire pointed in the direction you want to hear. DXers interested in ultimate no-compromise performance, and in analyzing the behavior of the signals they hear, need both horizontal *and* vertical directivity however. The first of these factors has received by far the most attention. We shall revisit it, but I wish to stress the importance of the angle of arrival of DX signals, and the vertical directivity of antennas here. Some of the references appended cover these and more general topics in greater detail, and give construction details omitted in the present article.

Horizontal directivity accomplishes at least 3 major goals. 1) It allows the targeting of specific areas, 2) it permits nulling unwanted stations, and differentiation for example between Africa and South America, and 3) it often facilitates discrimination against atmospheric noise. Vertical directivity accomplishes the above goals also, and often very dramatically. In addition, if an antenna can be persuaded to concentrate its sensitivity on signals arriving at low angles it will very often outperform– perhaps dramatically– antennas that receive high angle signals best. And the top-gun DXer's edge comes mostly from the low-angle performance of their antennas. Once you have made the step from a simple directive long-wire array, switchable to select directions of interest, the next logical move is to add the ability to null signals arriving at high angles. You should choose your antenna with the above in mind, and should ideally erect a number of antennas to perform clearly differentiated tasks. As conditions change, so should your choice of antennas. What works may vary from year to year, season to season, and even minute to minute. There are some signals you would kill for that may make it to your location for a matter of minutes per year. And the message here is that waiting for them, properly equipped, is *not* just a matter of blind luck– though it surely does not hurt.

Polarity of the antenna is of great importance to DXers. The incoming rays are themselves randomly polarized after even a single encounter with the ionosphere, but the type of antenna you choose gives you some control over the incoming angle best received. There are two major types of polarization to consider also; horizontal, and vertical, and despite the similarity of terminology these should not be confused with either directivity (above) or even whether the antenna itself is largely vertical or horizontal (below). Loop antennas may look identical in either case for example, but their polarity is determined by the location of the coax feed-point. And the famous Beverage antenna– a long horizontal wire– in fact performs as if it were responding to vertically polarized incoming waves.

VARIOUS APPROACHES

From the humble dipole to the elaborate yagi the quarter wave horizontally polarized wire or tube is the most common antenna variety. The main advantage is relative simplicity. The main disadvantage is that improvements in low angle performance come only from raising the antenna height. A dipole at one quarter wave above ground or less is most receptive to signals arriving from directly above. The lower the frequency, the greater the ground loss, and the more difficult it becomes to get the wire up high enough to perform well. I do remember full well butting heads on 40 meters with a New Zealand farmer who had a dipole strung between two hills 300 or more feet above ground, facing off down a broad valley to Europe. The dipole easily outperformed my two element rotatable beam, and opened and closed the band– when signals arrive at their lowest angles– most convincingly.

But since the high road is not open to many of us, serious DXers should concentrate their attention on vertically polarized setups. The Beverage is (perhaps surprisingly) the best example of a vertically polarized antenna. Incoming waves are tilted by electrical ground resistance and build signal voltage in the horizontal wire. The theoretical butterfly wing pattern of lobes fills in off the ends because of proximity to the ground, and unlike almost any other antenna, they work best over poorly conducting earth– as is the case at David Clark's DX barn for example. Terminating them in their characteristic impedance makes them usefully unidirectional, or more elaborate two-wire arrays allow easy direction switching. On the minus side of the ledger vertical polarization is particularly efficient at picking up man-made electrical noise, which makes such antennas noisy for receiving weak signals in urban environments. This is another reason why travelling-wave (long-wires) seem to fly so much better on DXpedition. But if you live in a subdivision with buried reticulation backing onto a ravine, as I do, or in rural splendor as David did till recently, it is very hard to beat 4 or more low wires one to two wavelengths long pointed in major directions, as a receiving setup. The directivity varies enormously from night to night as conditions vary, but I usually see 3 and (rarely) as many as 5 S-units discrimination between say Africa (bearing 105 degrees, 500 feet of wire 10 to 20 feet above ground) and South America (175 degrees, 500 feet, 10 feet height). And a powerful argument can be made for making such antennas unidirectional with David's evolution from 'auroral donut short path believer' to 'prophet of the long path' between 1989 and the present. Most of the epiphany was accomplished by terminating his bidirectional long-wires. Interestingly perhaps my experience with yagi beams on 40 meters, and a 2-element vertical switchable array on 80m in New Zealand allowed the expectation of afternoon Indonesian reception from Toronto as the norm, rather than the exception, and to anticipate that these signals would be coming via longpath. And when signals arrive along a broad horizontal front– often the low-band case– concentrating on vertical directivity may accomplish more than improving azimuth gain when seeking improved signal strength. Note also that while a long-wire extension of two-wavelengths seems about the optimum length-for-gain trade-off, longer arrays show improved low angle performance. Legend attributes better DX characteristics to Beverages than they fully justify, as low-angle receptors at least. This is no doubt in part because the cogniscenti invariably set them up as close to saltwater as possible, where low angle performance is much enhanced.

The erection of large yagis remains a fantasy for most DXers, although there is of course no intrinsic reason why this should be so. Committed hams have erected 3 and 4 element full-sized beams on 80 meters after all, and the results are dramatic, and well above that to be expected by the theory of moving from a one- to two- to three- element design. Just how much can be gained, and why? From my Auckland NZ ZL1AZV site I operated on 40m with a vertical mounted on a tin roof for excellent elevated ground conductivity, and compared signals with Mike (now ZL1HY) frequently on his regular weekly sunset schedule over the high-absorption South African path. I was typically S2, and Mike S9+5 dB. I built a fair copy of the linear-loaded KLM design 2-element double driven beam—that Mike also used in two stages, and put it up at the same 65 foot mark on the tower. The first week I tried a single element version– basically a shortened rotatable dipole. My signal jumped to S7. The following week I had the second element in place, and the beam tuned– boy have I left out a few details here!– and now my signal was equal to Mike's over this difficult path. Don't be misled by the theoretical gain figure of 5.6dB for a 3-element yagi over the humble dipole. When the angle of signal arrival is taken into consideration the difference may often be 5 S-units or more. This is also why monoband yagis comfortably outperform even well-designed tri-band beams. In a single-band design cancellation of unwanted high angle lobes is much more completely realized than in the multiband beam– or in the wide-band many-element log periodic design favored by the military and some international broadcasters.

My most dramatic illustration of this effect came when I mounted a tri-band beam above a highly optimized 4-element 20m monoband beam prior to a Chatham Island trip discussed elsewhere in this Proceedings volume. On the morning longpath ragchew into Maritime Canada over Australia the Sydney regulars in the 3-way were S9 on the (higher) tribander, and S3 on the 20m mono-band beam. At the business end of the path in Canada the results were reversed, with the mono-bander far the better performer. But even that antenna was put to shame in comparisons with Mike's very long-boom 5-element mono-bander, on the particularly tough long path from New Zealand, west three-quarters of the way around the world to the high pampas of Argentina. While height alone controls the actual angle of lobes leaving an antenna, the intensity of these lobes is affected by the interaction between the elements. Signal leaving at high angles is lost to the more desirable lower angle lobes. Long-boom designs are much easier to tune for this than those with shorter booms, or compromised for multiband operation. No gain without pain!

FAVORITE SKYWIRES

Fewer SWL DXers specialize in single spectrum stretches than do hams of course, and thus the task of erecting monoband antennas to cover a wide range of frequencies tends to inhibit experimentation. Optimizing a monster for 4800 to 5060 kHz is not beyond the resources of everyone however, and there are other routes than the big yagi to consider. Loop antennas– deltas, quads, squares, rectangles– have shown a lot of promise. The delta loop supported at two points, apex down, and fed at either of the upper corners favors an arrival angle of a bit less than 30 degrees. That this is a vast improvement on the performance of a dipole at a similar elevation– and little more difficult to mount– I have demonstrated to my own satisfaction many times. Closed loops tend to be quiet antennas also, and this makes them good for listening in particular, even though they should be in vertical polarization configuration for DX use. The single-band bob-tail curtain is a deserved favorite for low-band work, and it has simpler variants that require little attention to ground conditions. I recently erected the commercially available Carolina Beam and its impressive performance on low angle signals is discussed in a review by Guy Atkins, elsewhere in this publication, that contains some of my comments. This is a multiband design with great promise. I hope to explore the possibility of a 2-element version optimized for 90 through 60m that could be phased to give a switchable pattern. Similarly, should you have two high trees aligned suitably it is not difficult to experiment with multi-loop arrays favoring suitable directions. A high rope supported by pulleys to the trees allows easy access for the inevitable fiddling, maintenance, and tuning.

Verticals and arrays of verticals are easier to work with than most believe. Their main drawback is the requirement for an extensive ground system, but even this is not too difficult for the weak-signal impaired. A loop of #6 copper wire with radials about one-quarter wave long each braised to the loop and laid over the ground is all that is required. Lay that down before the first flush of spring, and pin the end of each radial taut with a nail, and the earthworms will bury them for you in weeks in any humid climate. I have had friends who used chicken mesh successfully as a ground net! Low angle performance is again the payoff for effort. The better the ground system the lower the ground loss and the more efficient the antenna's performance– particularly at the lowest angles. Radials should number 16 or so to start, if possible, and if you add more, double the number each time– to 16, then 32, then 64 and so on. The poorer the earth (dry, stony, bedrock) the more attention needs be paid to the ground. As with dipoles there is more payoff than you might expect from doubling the array to two, and then four elements, and once again low angle performance is the chief beneficiary. Amateur switching networks to phase 2- or 4-element vertical arrays are fairly easy (though not cheap) to come by.

Using phased verticals in 80 meter band contests gave spectacular results for me as ZL1AZV. There is one condition though which makes an interesting point. I had the good fortune to operate on both 160 m and 80 m using a 200 foot (temporarily) disused broadcasting tower from New Zealand. This was at a site fairly close to the ocean, with full Broadcast standard ground radial system. On 80 meters this tower was close to 5/8 wave tall, which gives a fine low angle lobe. And when the band went long you could hear the difference, against almost any other antenna– it was quite spectacular. But some careful comparisons under a range of conditions with Mike, who was using a traditional quarter wave vertical with an adequate radial system (when the goats left it alone!) showed that for much of the time under moderate sunspot number conditions the shorter, higher angle radiator, performed as well or even better than the big stick. As the MUF drops with the sunspot cycle too low an angle of radiation (or reception) can fail to get a signal off to a good launch. I am sure that at sunspot minimum (close, at present writing) such an antenna would enjoy more success more of the time.

In general antennas should be full-sized when possible for DX purposes. Some compromise is of course possible and may be essential for the low-bands where size is getting to be a problem. Verticals can be capacitively (top-hat) loaded with little performance loss for example. Wire and/or tubing sizes should be large where possible. Taper of aluminum tubes is an acceptable compromise. Greatly shortened antennas are ticklish to match, and easily detuned by metal objects around them. This is less of a problem for receiving than transmitting, but still always a consideration. Low efficiency antennas may show improved Signal/Noise ratio, and provided the signal is there in the first place, this can be a benefit– as in the classic broadcast loop. The T2FD design , as has been noted by Guy Atkins, is a neglected loop variant with interesting DX characteristics, and the very low profile DDR antenna is another design to consider. Both of these antenna types have been explored in previous Proceedings volumes. Variants on the sloper have been used to good effect by many– including me– but it is often forgotten that this is really one half of a dipole fed at the top. It thus is missing the second side to work against. In a typical ham installation comprising a series of wires draped off the tower below a tri-band beam– providing an inverted ground-plane– the antenna can be expected to exhibit far better characteristics than the "solo on a wooden pole" configuration adopted by many SWLs.

Thus a ripe field for DX research remains antennas. While there are still many lessons to be learned about the azimuth of arriving signals I suspect some real gains are to be made concentrating on vertical angles of arrival, perhaps by experimenting with some of the new phasing networks becoming available. For many of the weak paths of interest to the Tropical Band DXer low and very low angle receiving antennas are an essential tool. And it is after all impossible to have *too* many antennas to choose from...

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The ARRL Antenna Book, published regularly and updated by the ARRL

Plus see the (currently) three ARRL Antenna Anthologies of *QST* articles in print.

BEVERAGE ANTENNA ARRAYS

Two Approaches

Don Moman, VE6JY and John Bryant

ON THE MOVE AGAIN: MOMAN

Much of the following discussion on beverage construction and remote antenna switching has recently been put into practise at my new antenna farm. As hinted at in my article for *Proceedings 1992-1993*, "Listening to a Dream", I have moved a little further out of town onto 80 acres ideal for antenna farming. At present I have two beverage arrays; one full rosette in the center of the property and one half array at the west boundary. The second site allows longer

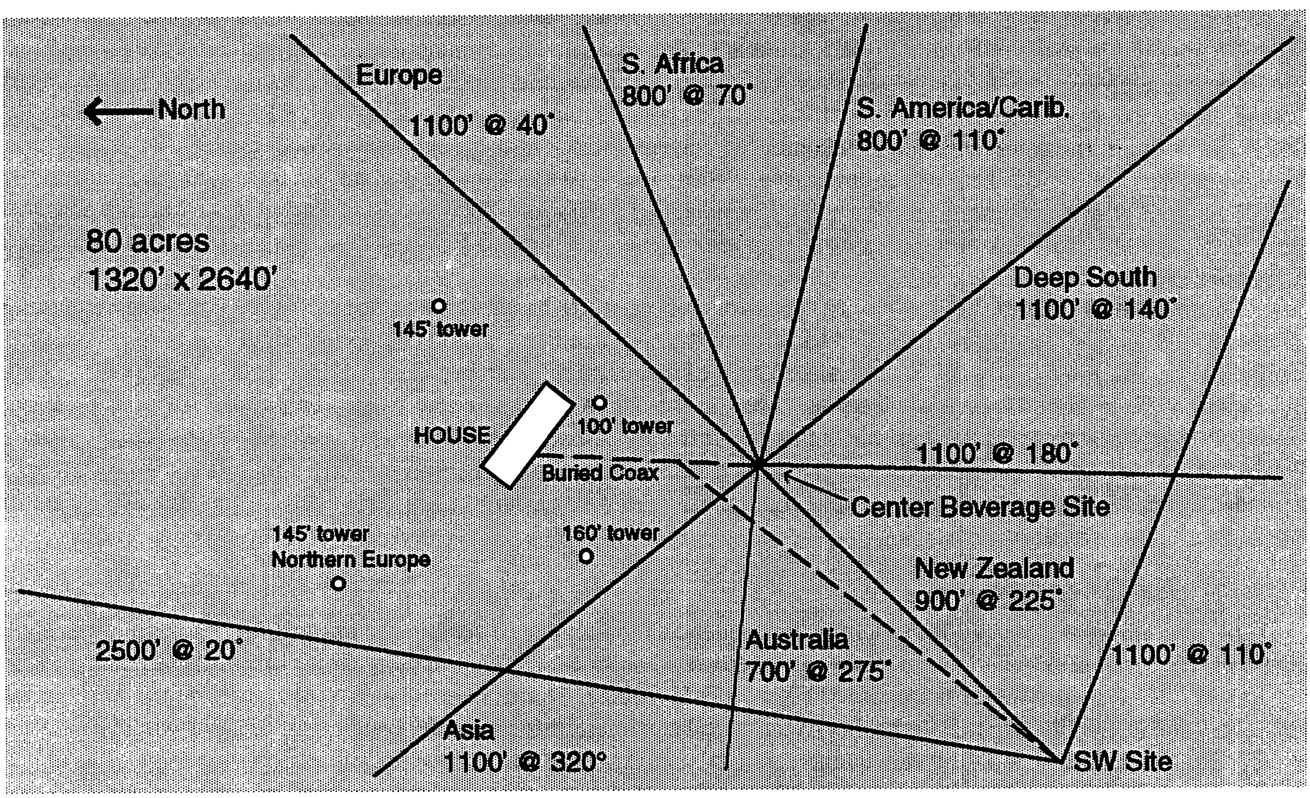


Figure 1. Beverage layout at VE6JY

beverages into Europe, Africa and South America. Some of these may become remotely reversible and steerable in the future. The first site is 450 feet away from the radio room and has 8 beverages centered at 40, 70, 110, 140, 180, 225, 275 and 320 degrees. Length varies between 700 and 1100 feet. The second site is 1400 feet away and will contain several more beverages, although not all of them are completed. The longest is 2500 feet long at 20 degrees, great for hearing Yellowknife, NWT on 1340 kHz but not much else so far. Feedlines are RG-8, RG-11 and CATV hardline. Only a few of the beverages have been properly terminated but I will finish that task this summer. Most of the beverages have their own impedance matching transformers, constructed when researching matching techniques, for *Proceedings 1992-1993*.

A Sony AN-1 active antenna is mounted at the convergence of the eight beverages at the first site, about fifteen feet above ground. I am certain there is some interaction between the AN-1 and the beverages, because the Sony has never worked better! It makes an ideal omnidirectional choice for casual listening and scanning. The beverages can then be selected to further improve the signal and determine the direction of signal arrival. This can be quite useful as it has been my experience that signals often arrive at other than their direct bearing. I used this beverage array on a daily basis throughout this past winter. Obviously certain paths are Long Path, like 60 meter Africans at 1700 UTC in the winter but many other paths can be quite skewed from either Short or Long Path bearings. This is most common on European signals, which often come in best at 70, 120 or even 150 degrees. This is directly related to geomagnetic disturbances which disrupt the normal polar route. This past evening the northern lights were incredible, WWV indicated major to minor storming and the BBC on 3955 was S9+ on the southern beverage but barely listenable on the "proper" 40 degree beverage. At this latitude (53 north) a skewed path is very common. This has prompted me to add several beverages to fill in various gaps. One remaining gap is at 90 degrees, which may be useful under certain conditions.

The technical and theoretical aspects of beverage antenna have been well covered in past issues of *Proceedings*. Some of the more practical aspects will be discussed here especially dealing with remote feeding and switching, with ideas that are applicable to both weekend DX'pedition or permanent beverage installation, big and small. While the word "beverage" will appear many times, please keep in mind that most of the discussion on wire, feedlines and remote switching schemes could be equally applied to other types of wire antennas.

WIRE: MOMAN

For permanent installations, a steel cored wire with a higher conductivity coating is desirable. Since the majority of RF energy flows on the surface of the conductor, the core material need not be an especially good conductor. The ideal wire is copperweld -- a copper covered wire with a steel core. The steel adds a great deal of strength and reduces the stretch, which occurs when using pure copper wire. Copperweld is very stiff and springy and not pleasant to work with. It's not all that common to find locally, although I do see one ad in a amateur radio magazine for a supplier who has 14 gauge copperweld for 7 cents per foot. A similar type of wire is the "electric fence" wire which is galvanized instead of copper covered steel. It also is stiff and springy but is common in most parts of the country at farm supply stores and is quite inexpensive at about one cent per foot in 1320 foot rolls. It's very strong and can be pulled tight enough to span 300 to 500 feet with minimal sag. While you're at the farm supply store, you might stock up on the various types of plastic insulators you'll need to complete the installation. They also offer fiberglass stakes that could be used to hold up the wire. However, they are quite expensive and only three to four feet high. Perhaps they can be ordered in "giraffe" size?

Unfortunately, none of the above wire types are well suited to beverage expeditions. There you want something easy to work with that can quickly be rolled back up on the reel. Insulated wire is best so the additional task of installing insulators can be avoided, at least for a weekend type of installation. Stranded wire is better as it is less likely to kink and break. Soft, insulated, stranded "hookup" wire in the 18 to 22 gauge size is nice to handle but may be fairly expensive. Surplus stores and amateur radio flea markets may often have suitable wire available. I was lucky to find a number of reels of teflon insulated, 22 gauge stranded wire at a local surplus shop for only 5 dollars for 2000 foot roll. This insulation, besides being very tough and light, makes the wire easier to retrieve because of the slippery nature of teflon.

FEEDLINES: MOMAN

At mediumwave and the lower shortwave frequencies the choice of feedline is not critical. Losses are not high unless the cable run is extremely long. Coax can be either 50 or 75 ohm, both will work well. Suitable types include RG-58, RG-59, RG-6 or the larger diameter RG-8 or RG-11 cables. The thinner types are obviously more suitable for temporary and DXpedition installations. For direct burial and longer life under any conditions, RG-213 would be a good choice. For a first class installation on a budget, an ideal choice would be 75 ohm CATV coax. Roll ends are often cheap or even free from cable TV installers. I was lucky enough to spot an ad in a local newspaper for a giveaway item - 7 large cable reels. These make handy picnic tables or workbenches but much to my surprise, I found they still had anywhere from 100 to 800 feet of half and three quarter inch CATV hardline still on them! This type of hardline is ideal, it uses a solid aluminum jacket covered with a tough plastic coating designed for direct burial. This type of cable also has a very sticky substance just under the jacket, which prevents water from migrating under the jacket should a small nick occur. These are referred to as "self healing" types of hardline. Bare aluminum CATV cable such as that used for overhead cable TV wiring is not suitable for burial, as the exposed aluminum may not survive long in some types of soil.

Connectors for CATV coax are expensive but alternatives are available from your local plumbing store for a dollar or two. Half inch 75 ohm CATV hardline with the jacket removed, is exactly the right size to take a half inch copper compression fitting. The barrel of a PL-259 coax connector is also this exact size! Bare enough of the center conductor to solder into the center of the PL-259 and you have a solid, reliable RF connection good into the VHF region.

REMOTE ANTENNA SWITCHING: MOMAN

Designing the whole system for maximum flexibility in receiving has been an ever increasingly complex task, as the number of beverages grow. In addition to the SWL aspect, amateur radio contesting with multiple transmitting and simultaneous receiving needs has to be figured into the antenna switching system. The system that John Bryant describes in his article is perhaps the most basic and at the same time, a very flexible approach. One relay per antenna, one control wire per relay allows multiple beverages to be connected together, occasionally providing a combination that my case where I have 8 or more beverages. Flipping toggle switches to see where the signal peaks is not nearly as convenient as rotating a switch. If possible, the switch could be set up so the indicator also shows where the beverage is pointing.

Because of the number of beverages and the distance involved, I have used a somewhat different technique. Four conductor telephone type wire is quite inexpensive compared to other types of control cable so my system is built to switch up to 8 antennas using just 3 wires plus ground. Each additional wire will double the number of antennas so I could expand to 16 antennas using only 4 wires plus a ground. One could expand the system even further without additional wires by using steering diodes and/or zener diodes along with both plus and minus DC voltages as well as AC. However, this can get a little tricky and I have an aversion to using diodes around RF, since they can rectify and create mixing products.

My system is modular in construction with each SPDT relay in its' own box. I used weather proof diecast aluminum boxes with BNC connectors. This allows for easy modification and maintenance. BNC connectors are easy to mount and work with but they had an unexpected advantage that I discovered last season. Some of the beverage transformers in my initial system had SO-239/PL-259 connections. The tension in the wires is significant and the wires can build up quite a vibration, which travels down to the matching transformer. This vibration would loosen the ring on the PL-259 and back it off, causing all sorts of noise due to the lack of a solid shield connection. BNC's with their twist lock action gave no problem at all.

Most general purpose low power relays are quite suitable for use as low and medium frequency antenna switches. I use small 26 volt military surplus relays, the type that are hermetically sealed in a small metal can. This should prevent oxidation of the contacts from a harsh climate out there. Isolation between the adjacent contacts in the relay can be measured using a signal source and an attenuator. Isolation decreases with increasing frequency, but most common relays provided at least 50 db at 5 MHz and 60 to 70 db at medium wave frequencies. In the interests of maintaining a sanitary beverage pattern, each matching transformer is switched between two adjacent beverages. In this way, the lead-in to each transformer input can be kept to a minimum. Again, this makes repairs easy. By adding more units the system can be expanded. Certainly this system or any of the ones described here are not limited to switching beverage antennas. I would be comfortable using these for any type of HF receiving antenna and even up to 100 watts for transmitting, more if larger relays were used.

When current flow in a relay coil is interrupted, a back voltage or EMF is developed. This voltage can be quite high and although it's not likely to harm anything with the sizes of relays we're using, it's a good idea to suppress this switching transient as much as possible since it can produce an annoying pop in the receiver each time you switch antennas. A diode connected across the coil with the polarity such that it conducts only on the back EMF will help.

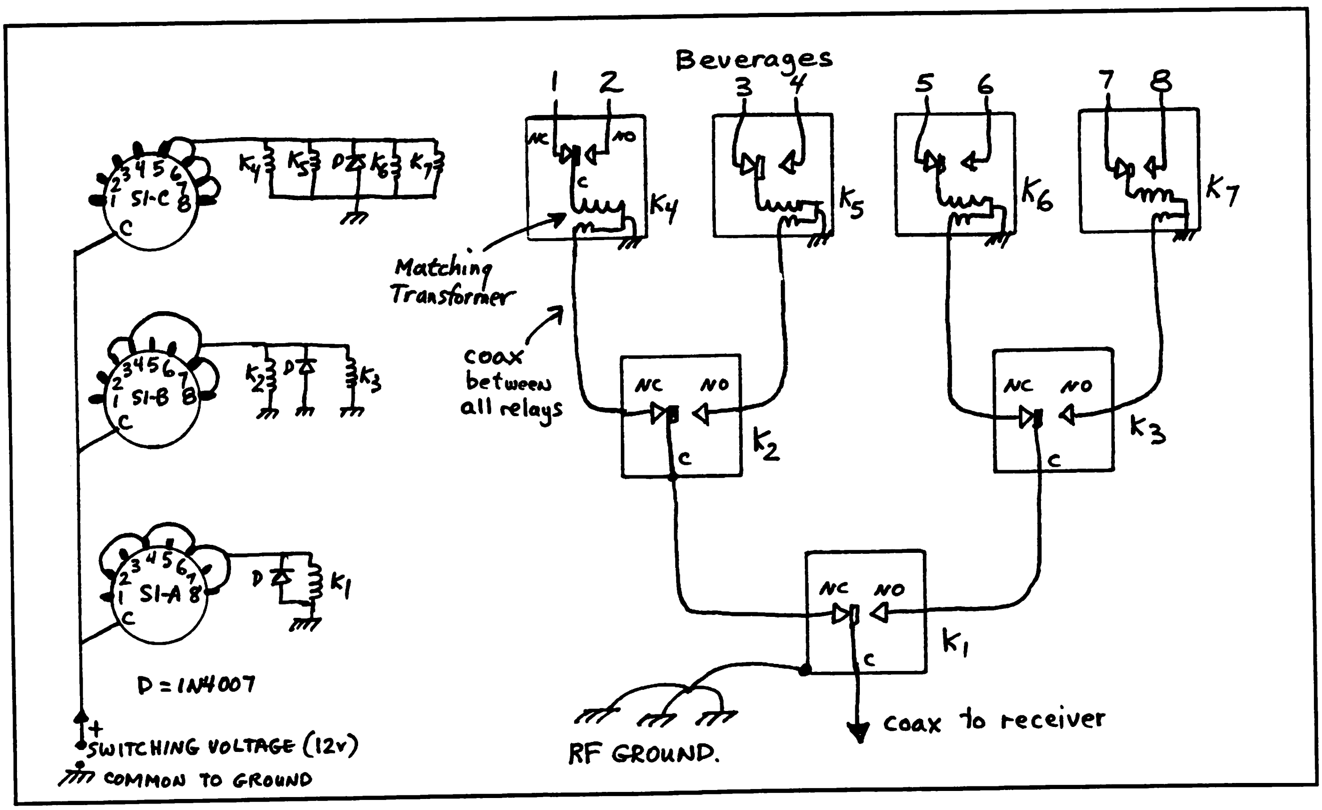


Figure 2. Switching 8 antennas using 3 control wires

Another type of switching that I have experimented with in the past is the rotary type, which can be driven by low RPM motors or rotary steppers. A common and inexpensive source of 12 volt 4 position rotary steppers is found in old 8 track players, as they were used to change tracks. Disadvantages of this type of switching are the larger control conductors needed due to the higher power necessary to switch, and lack of nearly instantaneous A/B comparisons. Also without some sort of indexing scheme, it can be hard to determine the position of the switch. They are better suited for adjusting the termination resistor value, something I intend to experiment with in the future. With proper coupling and isolating components, ratcheting type stepper switches could be driven directly using the beverage wire as the conductor, thus saving a great length of control cable (figure 3). This same technique can be used to send DC over a coaxial line at the same time RF is flowing back into the receiver, such as is usually found in an active antenna. This technique can also be used for remote relay switching in beverage systems. You could, for example, change the length of the beverage by switching in or out additional segments of wire. Such a system is described by ON4UN, John Devoldere, in his book on *Low Band DX'ing*[1].

The value of capacitors and inductors is not critical. The capacitor serves to block DC but pass the RF. A .1 uf capacitor has a reactance of 1.6 ohms at 1 MHz so its' effect as a series resistance is negligible. The inductor serves the opposite purpose; it must pass DC and block RF. A 1 mh inductor has a reactance of 6280 ohms at 1 MHz, again a small shunt resistance in a 600 ohm (approximately) system. The small wire used in the inductor may cause a problem if you are trying to pass enough DC current to drive some larger relays. Inductors used for 12 volt DC power line filters on car stereos would be a good choice, providing they have enough inductance.

If you are using the Mini-Circuit type wide-band RF baluns, care must be taken not to exceed the power handling capability of their extremely small core and windings. C2, C3 and L2 serve to bypass DC around the transformer. If a more robust transformer is used, it would be simpler to install a single .1 uf capacitor in the ground lead of the transformer.

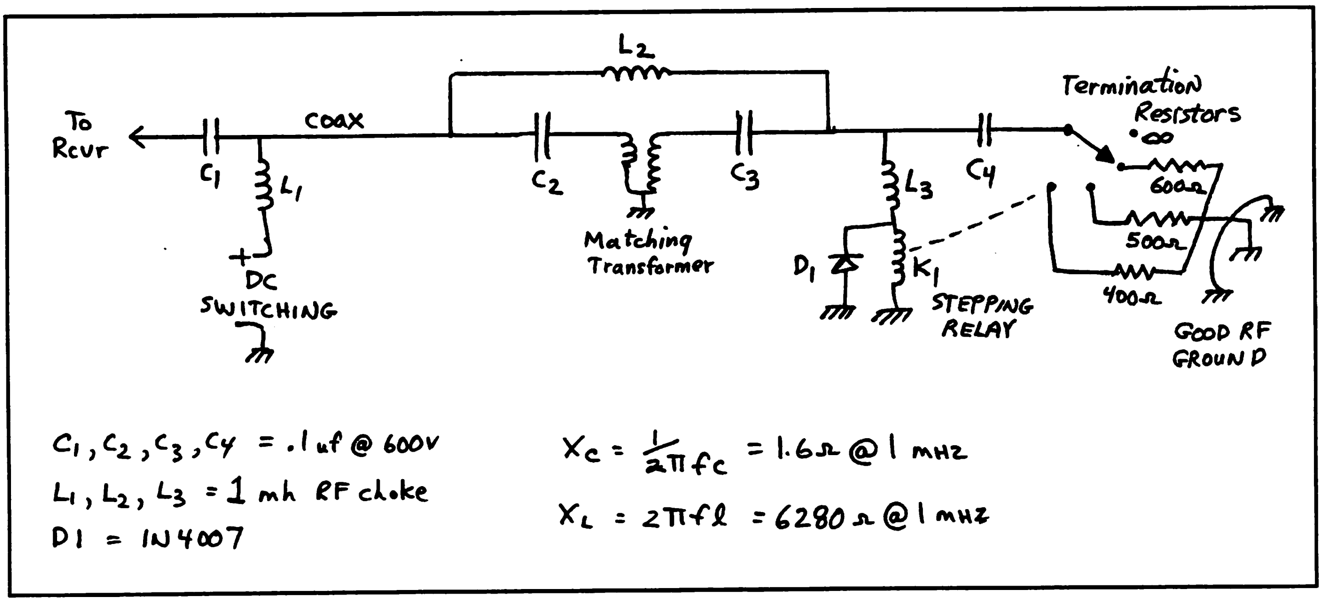


Figure 3. Basic DC switching and isolation techniques

I look forward to much more experimenting with this array, as I plan to improve the RF grounds at critical points, add termination resistors to all the wires and fill out the second SW site with even more beverages. Even at this stage, using the array has been very rewarding. Later this year, I hope to reinstall the log periodic at about 90 feet here at the new site, and it will be most interesting to compare the log with the beverage array. The results might even make an article for a future *Proceedings.*

A HALF-WAGON WHEEL OF BEVERAGES: BRYANT

Most of us have a dream antenna system we suppose we could never afford. My dream had always been to have a permanently mounted 'wagon wheel' of Beverage antennas, with me DXing away at my favorite rig in the middle. I knew it was an impossible dream; I could never afford the thousands of feet of antenna wire and coaxial lead-in, much less the land to put it on. Over the past three years, I've found that I was wrong on all counts.

My first discovery was that antenna wire wasn't as expensive as I thought. I learned that many amateurs use smooth galvanized steel wire -the kind manufactured for electric fences - for Beverage wire. It turns out that RF currents flow on the surface of antenna wires and that steel wire works just as well as copper for most receiving antennas. I was still suspicious until I saw Bill Tippett's (WOZV) system he described in *Proceedings 1991*. Bill used electric fence wire drawn very tightly with posts and insulators at 100' intervals. 2500' rolls of electric fence wire sell for less than $30 at most farm supply stores. Some of the electric fence insulators are pretty nifty, too.

Next, I discovered an excellent source for coaxial lead-in: Davis RF (P.O. Box 230, Carlisle, MA, 01741 Phone 508-369-1738 or 1-800-484-4002, Ext. 1356) sells 52 ohm coax with excellent spec's for 17 cents/ft. in 500 ft. rolls.

I also learned that Beverages of about 450 to 500 feet are about optimum length for 60 and 90 meter DXing. I had always imagined needing much longer antennas. I now know that even 'mini-Beverages' of as little as 150' will exhibit some directional characteristics.

REMOTELY SWITCHED BEVERAGES: BRYANT

My real revelation was seeing Bill Tippett's antenna switching system while we were visiting in Colorado. Bill had a wagon-wheel system in a field next to his house. Five Beverages came together at the center of the field and were individually switched by a home brew system into one single coax lead-in, which then ran the 600' or so to his basement shack.

I had always supposed that Beverage switching systems had to be very elaborate to keep the antennas from coupling together and destroying directionality. NOT SO! Bill used 12 volt DC 'reed' switches from Radio Shack and ran a 6-conductor cable out to the switches to throw them ON or OFF. The gizmo was mounted in a plastic box. Bill switched the signals coming in directly from the Beverages and then had one ferrite toroid-based impedance matcher mounted right before the signal entered the coax lead-in. At first, I couldn't believe that so simple (and cheap) a system would work! It did. Each of the antennas exhibited very individual characteristics and, since Bill regularly 'worked the world' on 160 meters, the system was obviously a good one.

I developed my own switching system based on Bill's but using double pole single throw relay switches which are 'normally off' (RS part #275-248) as shown in Figure 4. As you can see, when the relays are OFF, the antennas are grounded to prevent static buildup and to reduce antenna interaction. When a relay receives 12 volts from my indoor control box, it switches the RF from that antenna to the 'bus' going through the impedance matcher to the coax lead-in. The entire switching system cost me less than $15 for the indoor control box and 6 control switches and about $20 for the outdoor box, perf mounting board and five relays. It works like a charm and, as far as I can tell, there is no coupling between antennas. Each antenna exhibits very distinctly different and distinctly directional reception patterns.

Besides saving a great deal of money on expensive coax, switching Beverages remotely also can allow you to arrange Beverages most efficiently on your land. I live on a semi-rural 'ranchette' site that is about 450' square. My house is in the middle of the site. (Figure 5)

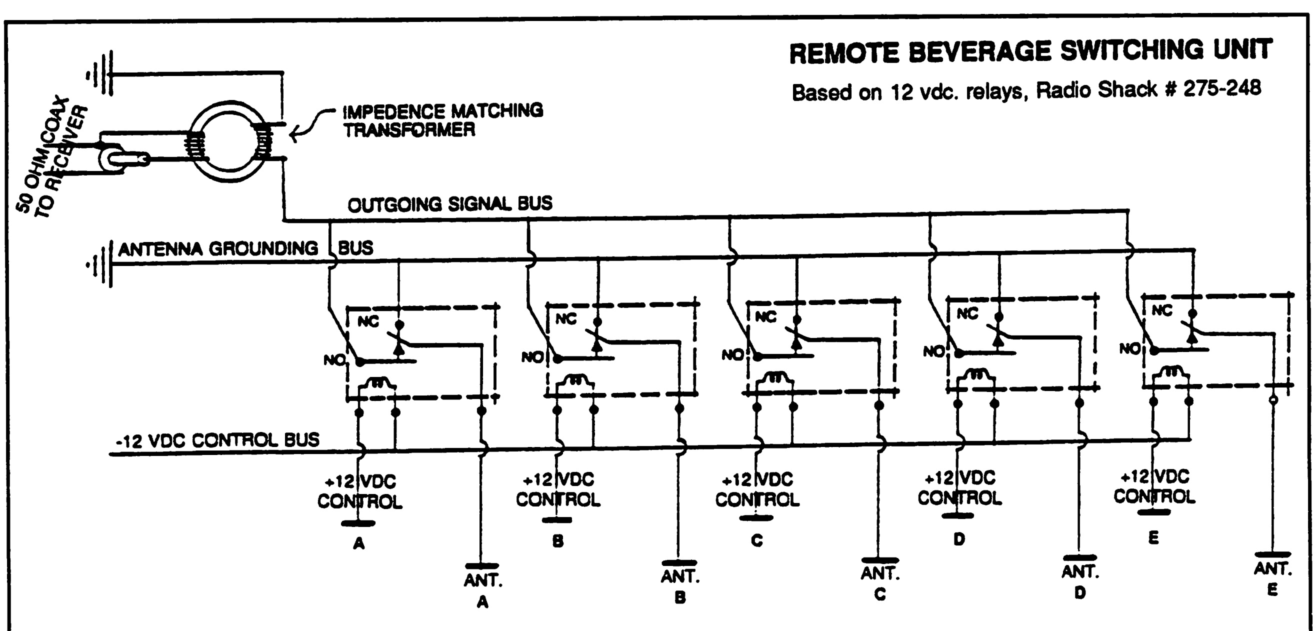


Figure 4. Remote Beverage switching unit

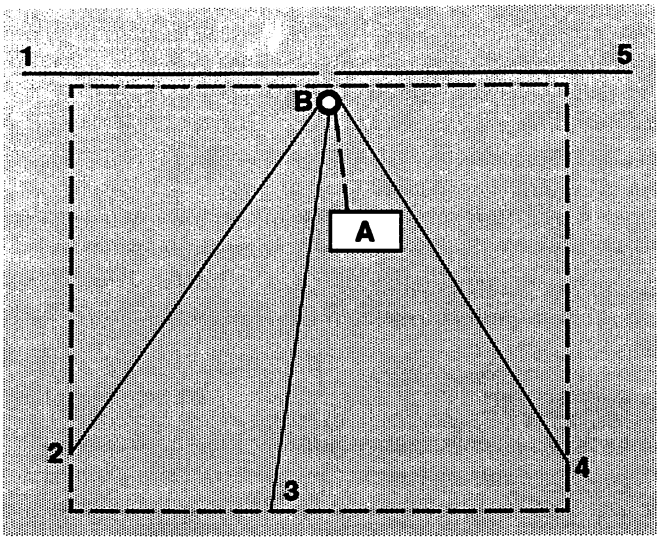


Figure 5. A=House B=Beverage Switching Site 2,3,& 4=450 ft. unterminated Beverages 1 & 5=750 ft. terminated Beverages on the fence line

As you can see, by leaving Beverages 2,3 and 4 unterminated, I can cover dawn Long Path to Asia and evening Short Path to Europe with Beverage 2. I aim right at evening Long Path to Asia, Short Path to southern Africa and dawn Short Path to East Asia with Bev. No.4. I cover dawn Short Path to central and south Asia with Bev. No.3 which is also my best Latin antenna. Beverages 1 and 5 run on the fence line and point at mid Pacific and western/central Africa respectively.

THE AMERITRON REMOTE COAX SWITCH MODEL RCS-8: BRYANT

Several months ago, I learned that the Ameritron Corporation (Ameritron: 921 Louisville Road, Starkville, MS 39759; (601) 323-8211; Fax: (601) 323-6551. RCS-8V costs $149 w/SO-239s, $169.95 with Type-N connectors. They also have a 4-position remote switch, the RCS-4, priced at $134.50. Prices per Feb. '94 *QST*) manufactures and sells a very nice remotely controlled coax switch which will handle up to five transmitting or receiving antennas. The unit sells for under $200 and works much like my home-brew system. The remote switch itself is remarkably well built and uses five large relays mounted directly on a glass PC board. The switch is a COAX switch, so input to the switch box must be via 52 ohm coax. For us, this means using an impedance matcher at each Beverage and then a short run of coax from each matcher to the switch.

The control box in the shack is also very well made with LED's which light to indicate the antenna in use. The antenna selection switch in the Ameritron unit is a rotary switch. This limits you of course, to having only one antenna active at a time. My home brew system, using 5 SPST in the shack, allows you to have any or all antennas active at the same time.

If you would like absolutely maximum antenna isolation and would rather not build your own switching system, the Ameritron RCS-8 is very nice.

DO YOU REALLY NEED THIS: BRYANT

If you can string several mini-Beverages on your property (or that of friendly neighbors), I'd strongly recommend that you at least invest in a homebrew system similar to one of those covered in this article. My now three year old 'new' antenna system has improved my DXing ability more than any new receiver ever has! After Tippett's *Proceedings 1991* article convinced me that Tropical Band signals often can and do follow the Long Path, I put up my half wagonwheel. In less than one season, I logged all but two of the twenty-some All India Radio transmitter sites. I heard Tropical Band Subcontinentals VERY REGULARLY and very well from late October until early March rather than the 'normal' 6 to 8 week midwinter 'Subcontinental Season.' Almost 100% of those receptions were Long Path on the Beverage pointing southwesterly. Even on those few occasions when Long Path signals were only equal to Short Path signals 'over the Top', the Long Path was significantly quieter. I should note that after two wonderful Indian Long Path seasons (91-92 and 92-93), the 93-94 season has been very disappointing on 90 meters. Short Path seems to be dominating this season and signals from the Subcontinent seem to down generally.

The single greatest advantage of a multiple Beverage array similar to ours is the significant improvements in signal-to-noise ratio. Directional antennas only 'see part of the sky' and therefore only part of the noise. My current system lets me maximize signals and minimize noise.

---

[1]Devoldere, John. ON4UN *Low Band DXing*. ARRL 1987, pp II-120

receivers

THE WATKINS-JOHNSON HF-1000 DIGITAL RECEIVER:

First Impressions

David Clark and James Goodwin

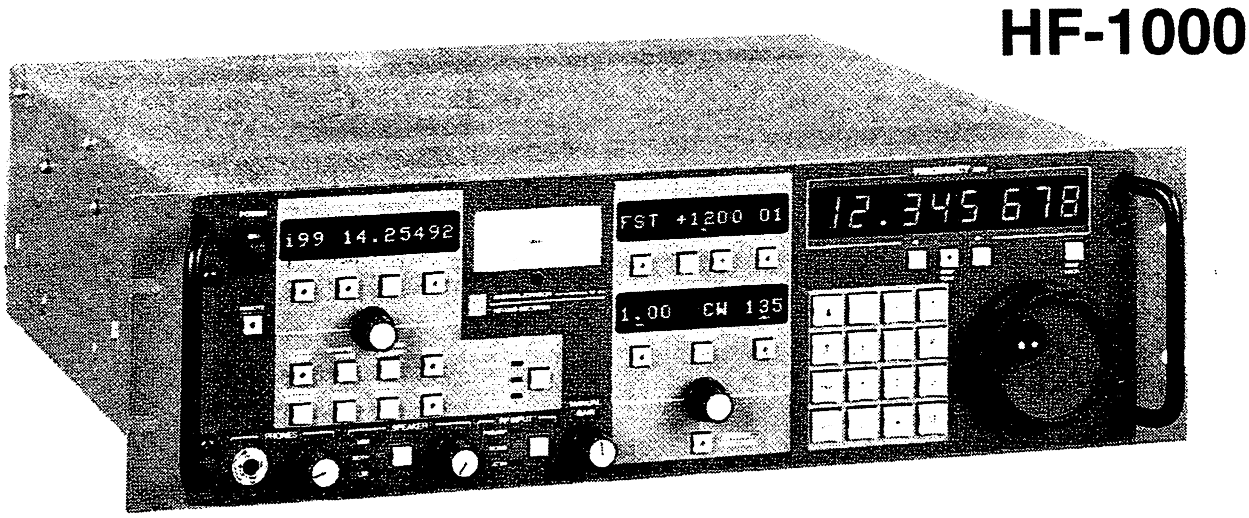


Figure 1. MODEL HF-1000 GENERAL COVERAGE RECEIVER

INTRODUCTION

The Watkins-Johnson HF-1000 has created a great deal of interest among DXers and SWLs since it was introduced in September of 1993. It has almost everything anyone could want, including some features no hobbyist could have even dreamed of just a short time ago. The capabilities of its digital signal processing circuitry give us an early view of what is coming in the years ahead, but at a price approaching $4,000.

Late last winter, David Clark obtained an HF-1000 on a brief loan from Norham Radio, a leading Toronto-area dealer which is also the sole Canadian retailer of the receiver. Although Proceedings normally waits at least a year after the first reviews of an important new product are out to publish its "definitive user's review", this was too good an opportunity to let pass for some comment on an initial test run.

What follows is not intended as an exhaustive review. We give an outline of the HF-1000's major features and state our findings from a rather abbreviated test period. We have added our individual remarks where appropriate, in italics and they are indicated by (DC) and (JG).

After our receiver try-out, Watkins-Johnson introduced a firmware upgrade providing synchronous AM detection and programmable AGC. Included is some Company-supplied information on these features and on future plans we learned in June, 1994 discussion with an engineering representative.

In order to provide a broader perspective, we have also incorporated other user comments posted in recent months on computer bulletin boards. The authors wish to acknowledge the co-operation of Ben Krepp in forwarding a number of the postings to us.

We also acknowledge the cooperation of Bill Bowers and John Bryant who made available some test results which relate the digital RF interference generated by the HF-1000 in comparison with several other currently popular, high-performance communications receivers.

RECEIVER AND CIRCUITRY

Anyone who has used only the consumer-type communication receivers of the last 20 years may find the HF-1000's size initially unsettling. Because the HF-1000 has been derived from the WJ-8711, a receiver designed for military/commercial use, some of its dimensions were designed to meet rack-mount requirements. The receiver is 19 in. wide, 5.25 in. high and 20 in. deep. Modern miniaturization makes for a rather empty box weighing only 15 lbs.

The HF-1000 consists of an analog tuner, IF digitizer, digital signal processing and analog reconstruction circuitry, and front panel control logic. These operating components are contained on three printed circuit assemblies which, with the power supply, comprise the complete receiver. At first glance it appears deceptively simple. In reality it is an extremely complex unit, incorporating extensive state-of-the-art DSP processing capabilities.

The receiver is tunable in 1-hertz increments over the range of 5 kHz to 30 MHz. Detection modes are synchronous AM (see further notes following), FM, CW, USB, LSB and ISB.

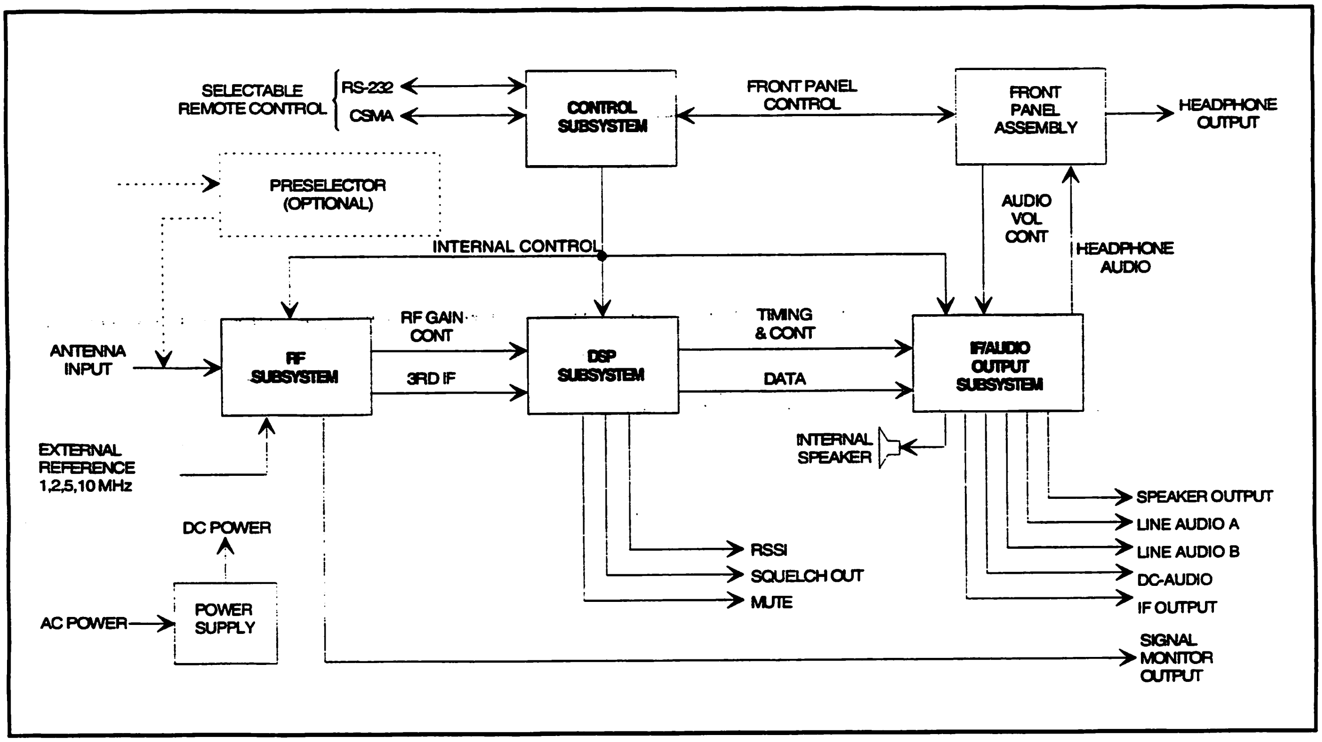


FIGURE 2. HF-1000 SIMPLIFIED FUNCTIONAL BLOCK DIAGRAM

Figure 2, taken from the manufacturer's Technical Data Sheet, shows a simplified functional block diagram of the HF-1000. The received RF signal is mixed with that of a first local oscillator, which tunes from 40.455 MHz to 70.455 MHz in coarse 1-kHz steps, to produce a first IF of 40.455 MHz. A filter limits the signal's bandwidth to 8 kHz. Further successive mixings with a 40-MHz oscillator and a 430-kHz oscillator produce 2nd and 3rd IF's of 455 kHz and 25 kHz respectively.

The 25 kHz signal is digitized to 16-bits resolution at a sampling rate of 100 kHz. The digitized signal is applied to a programmable DSP chip that performs the functions of noise blanking, fine tuning to 1-Hz resolution, IF filtering, passband tuning, tunable IF notch filtering, manual and automatic gain control, signal strength and squelch functions, signal demodulation and BFO, generation of a multiplexed digital data stream containing one or two demodulated audio channels, and a post-filtered IF signal.

The receiver's IF/Audio Output Subsystem then performs the analog reconstruction of the IF and audio signals provided by the DSP Subsystem in digital form. The reconstructed analog IF signal is upconverted to 455 kHz and made available at the receiver's rear. The reconstructed audio is directed to various audio outputs, including an 8-ohm 4-inch internal speaker under the receiver's top cover, the 600 ohm front-panel phones jack and the several outputs available from the rear panel.

MANUAL

The Manual which came with our test receiver is titled "Intermediate Level Maintenance Manual for the HF-1000 Digital HF Receiver". It is clearly written and fully explains the receiver's operation. With almost 200 pages of text and illustrations, it has chapters on general description, installation, local operation, remote operation, circuit description, maintenance, replacement parts (referenced by manufacturer) and schematics.

Every receiver coming off the assembly line is subject to an extensive burn-in and specifications check before it is delivered. A seperate bench test report is provided with each receiver too.

FRONT PANEL DISPLAYS AND CONTROLS

The size of the front panel has enabled Watkins-Johnson to provide numerous uncrowded and easy to use controls. Mostare single purpose, the principal exception being the Auxiliary Parameter Edit control knob whose functions are outlined below. The available space permits the luxury of four LED displays although there is no clock.

The front panel layout includes three shaded areas which group particular sets of keys which are associated with specific functional operations. The shaded area on the left side includes all keys and the display associated with the memory and scan functions. The shaded area in the center of the front panel contains the keys, displays and control knob associated with receiver auxiliary parameters such as detection mode, IF filter selection, tunable IF notch, Noise Blanker, Passband Tuning, and so on. Finally, the shaded area right-of-centre highlights the 16-key keypad.

The over-all arrangement is logical and with the very helpful Manual at hand, no new owner will need much time in to become a capable operator. The manual contains a large fold-out illustration of the front panel controls, LED indicators and displays, cross-referenced to the appropriate sections of the text. Figure 3 on the following page (taken from the Technical Data Sheet) highlights the ergonomics and some of the features of the front panel organization.

FREQUENCY DISPLAY AND TUNING

The tuned frequency display is a highly visible 8-character LED display, reading in megahertz. The display contains two digits, a decimal point, and six more digits, in the format xx.xxx xxx.

There are two tuning systems, the common decade method and Step Tune. Either the tuning knob or two up and down arrow keys may be used.

With decade tuning, the tuning-rate increment can be single hertz, 10 Hz or 10x multiples thereof, i.e. 100 Hz, 1 kHz, 10 kHz etc., all the way up to tens of megahertz. The increment is set by using the right and left arrow keys below the frequency display to move a cursor to the digit of choice. The position of the cursor is indicated by the digit which is constantly changing in intensity, a mild blinking that is not irritating.

The tuning knob is 2 ½" in diameter, has a fixed tuning dimple and is apparently unweighted.

The light-weight knob mechanism caused one of the few criticisms I had about the test receiver. The very small additional weight of the dimple seemed to be enough to upset the knob's balance so that when the dimple was in the 9-o'clock position, the slightest touch to the knob would set it in motion for a quarter turn to put the dimple down at 6-o'clock. (JG)

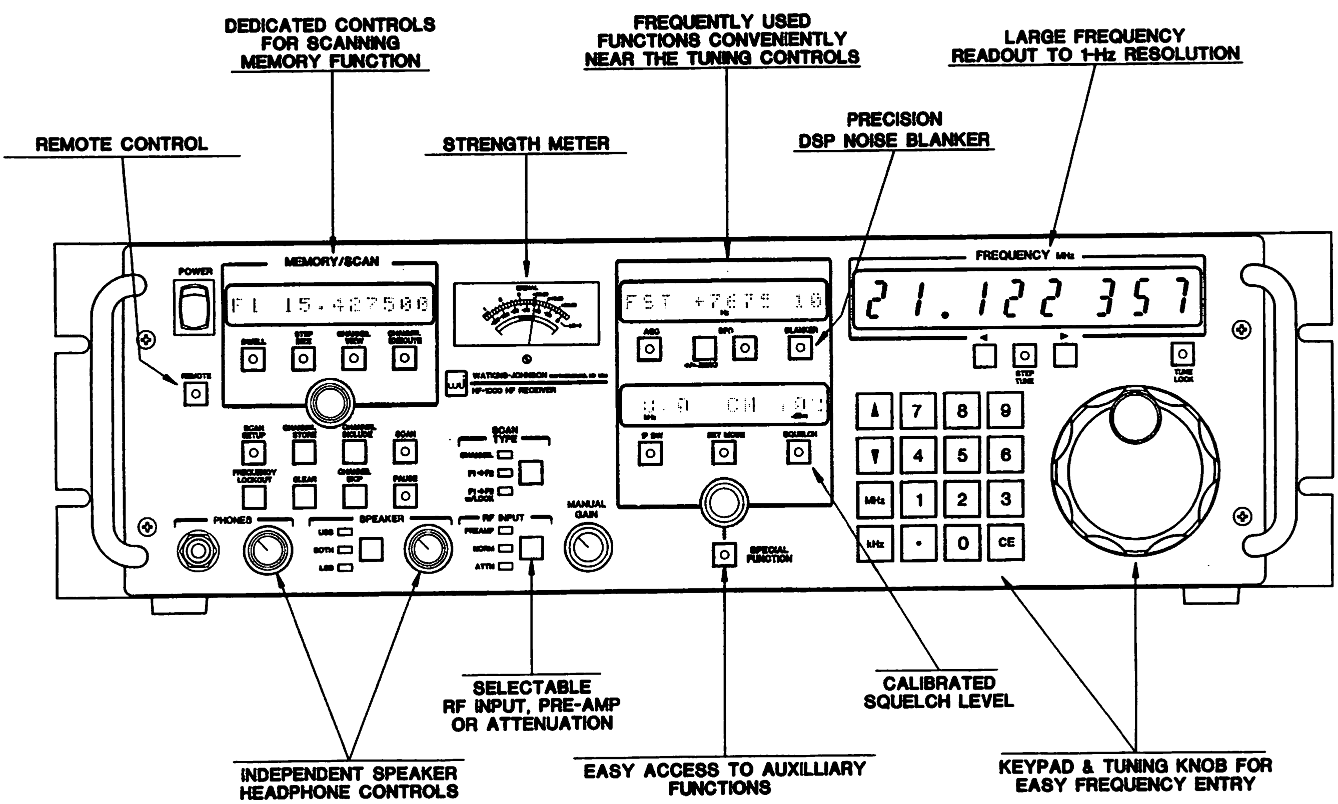


FIGURE 3. HF-1000 FRONT PANEL LAYOUT AND FEATURES

With decade tuning in effect, each press of either the up or the down arrow key increases or decreases the tuned frequency by one increment only. The tuning knob is the more efficient method of the two in most circumstances.

As an alternative to normal decade tuning, the Step Tune key may be activated. The step-size frequency increment currently in effect for frequency scanning in the Memory/Scan section then becomes the default increment for tuning - a change which is still made either by the tuning knob or by the up and down keys. This increment may be anything from 1 hertz to 25 kHz.

A Tune Lock key and LED can be activated to disable the tuning knob and the up and down arrow keys.

KEYPAD

The keypad serves for tuned frequency entry, either in kilohertz or megahertz, and for numerical entries for the various receiver parameters such as BFO etc. Included in the keypad are the MHz and kHz keys which serve as frequency-entry terminators. A CE or clear entry key cancels any partially made and unwanted entry.

We found the large, convex-shaped keys require a relatively soft-touch, making for convenient and error-free fingertip usage. On our test receiver, one of the numeric keys had a tendancy to stick when depressed and this sometimes necessitated repetitive re-entry of the intended frequency. This apparent mechanical fault causes us concern about the long term reliability of the keypad, since we have knowledge of another purchaser's situation where the keypad was also faulty. Hopefully these difficulties have been resolved in later production runs. (DC)

AUXILIARY PARAMETER SECTION

This section, at the center of the front panel, has two 12-character alphanumeric displays. The upper display normally shows the gain control mode, the BFO frequency and the noise blanking level. The lower display normally shows the IF bandwidth, the detection mode and the squelch level.

Below each displayed parameter (or function) is a combination key and LED light which when activated permits a change in the parameters' setting. While each of the keys may be repeatedly pressed to cycle through the respective parameters' setting choices, the all-purpose Auxiliary Parameter Edit knob is a more efficient method. For many of the section's parameters, this knob can be used to display and put into effect one of a parameter's settings.

The Special Function key is used to select Passband Tuning mode, IF Bandwidth Select mode, and a number of other functions which are infrequently used.

SELECTIVITY AND THE DSP FILTERS

One of the most talked-about features of the HF-1000 is its array of 58 user-selectable IF bandwidths with their excellent skirt selectivities and shape factors. The DSP circuitry has produced a capability that could not have been obtained with older, conventional techniques.

For the bandwidth specifications, Watkins-Johnson uses the width at -3 dB rather than -6 dB. The 58 bandwidths range from 56 Hz to 8 kHz at -3 dB, while the -3/60 dB shape factors vary from 1.45 to 1.20, depending on the bandwidth selected. The shape factors would be even more impressive if stated in the more commonly-known -6/60 dB ratio. In the SSB mode, only the widths from 900 to 3200 Hz can be used with the current software.

The user is able to select for quick access only those bandwidths ordinarily used. With the Special Function key, widths can be quickly added to or taken out of this up-front group. It is a simple matter at any time to activate the IF bandwidth key and with a twist of the Auxiliary Parameter Edit knob, to run through the up-front bandwidths and hear their effect on a signal.

I made a number of listening comparisons with the HF-1000 and my Racal RA-6790/GM. The Racal has only a limited number of crystal-lattice filters, and most have 60/3 dB shape factors of 2. It does have a 3.24 kHz filter with a factor of 1.33. I put both this and the similar DSP filter in the HF-1000 up against the worst adjacent-channel interference situations I could find, using both AM and ECSS modes. Lab tests might dictate otherwise, but I couldn't distinguish one receiver from the other. They both seemed to have the same relative successes and failures.

The HF-1000's narrowest filters are an improvement for the CW DX'er. The single-crystal Lamb filters in the old tube receivers could provide a nose selectivity of less than 50 Hz, but the skirts were several kilohertz wide. The narrow CW filters of modern receivers have much improved skirt selectivity, but their nose widths of possibly 100's of hertz don't permit the best signal-to-noise ratio for weak signals. This has often dictated the use of audio filters. The narrowest DSP filters either equal or improve upon the best features of past methods, although they may not give the signal boost that the Q that some Lamb filters provided.

While the range of DSP filters certainly offers the broadcast DX'er far more flexibility in dealing with "tight signal" interference suppression, they are tailor-made for the RTTY user too. No other receiver has had enough filter choices to deal well with the variety of RTTY bandwidths. The multiplicity of selectable DSP filters is a big step toward obtaining better signal-to-noise ratios for all manner of RTTY transmissions. (JG)

Bill Bowers tell us that he finds the 75 Hz position absolutely superb for DXing longwave beacons. For general SWBC purposes, however, Bill considers the Japan Radio NRD-535D to be his number one receiver and superior to the Drake R8 because of the flexibility afforded by the Variable Bandwidth Control.

I do little utility DXing (CW and RTTY modes) but side by side tests of the HF-1000 with a Drake R8 fed concurrently by the same antenna through a multicoupler rendered similar results, for approximately equal bandwidths on the Tropical Bands. (DC)

The following comment posted on Internet does, however, constitute another user's assessment of an apparent difference in performance between DSP and analog filters:

> *It seems to me in listening and comparing the HF-1000's weak signal performance that the difference has something to do with the difference between analog and digital filters. I can use a digital filter whose bandwidth is much smaller than an analog filter and hear about the same audio response. For example, the HF-1000's 1.8 kHz filter sounds very much like the NRD's (525 with Eska) 2.4 kHz filter. And yet filter curves I have generated on the NRD 2.4 and HF-1000 2.4 filters really do have that bandwidth. I think the difference lies in the phase characteristics of the two filters. It is possible to design a digital filter with linear phase, but the NRD analog filters are not linear phase. The phase rotation at the filter edge with an analog filter must allow more noise to get through with less coherent signal.* - John Reed, KA5QEP

SENSITIVITY, THE PREAMP AND ATTENUATOR

We found the receiver's sensitivity to be quite good, though unexceptional. Man-made and natural noise, particularly at lower frequencies, will be the limiting factors for most weak-signal reception.

The front panel RF Input key selects either normal reception, 10 dB signal preamplification or 15 dB signal attenuation. Preamplification is disabled when the tuned frequency is 500 kHz or less. On a 10 dB S+N/N basis, the HF-1000 is said to have at least the following sensitivities over the 500 kHz to 30 MHz range:

MODULATION	I.F. BANDWIDTH	STATED SENSITIVITY WITHOUT PREAMP	STATED SENSITIVITY WITH PREAMP
AM (50% mod., 400 kHz)	6.0 kHz	1.58 microvolt	not stated
USB/LSB/ISB	3.2 kHz	0.56 microvolt	not stated

My URM-25F signal generator is not a lab instrument, but it is fairly well calibrated. A number of current receivers I measured came out with figures well in line with their advertised sensitivities. I found the test HF-1000 did somewhat better than what is claimed. The following are the average measurements at many frequencies over the .5 to 30 MHz range. Variations were generally +/- 10 percent. (JG)

MODULATION	I.F. BANDWIDTH	MEASURED SENS. WITHOUT PREAMP	MEASURED SENS. WITH PREAMP
AM (50% mod., 400 kHz)	6.0 kHz	1.0 microvolt	.65 microvolt
AM (30% mod., 400 kHz)	4.0 kHz	1.3 microvolt	.85 microvolt
SSB	3.2 kHz	0.3 microvolt	.20 microvolt

Watkins-Johnson says the preamplifier gives a 10 dB signal gain and the attenuator a 15 dB reduction. I found this to be true, although my 10 dB gain figure was simple signal gain and did not take account of the increase in noise. With this taken into account, the net signal improvement provided by the preamp varied from 3 to 4 dB. Using a Grove TUN4 preamp/tuner instead of the receiver's preamp resulted in respective averages of .50 and .65 microvolt in place of the preceding figures of .65 and .85 microvolt.

As for the lowest frequencies, there was very little decrease in sensitivity from 500 kHz down to 100kHz. Even with high ambient noise and a modest Palomar amplifier/loop, there was enough sensitivity down in the 11 kHz area for me to detect at times the Omega navigational signals from North Dakota and Hawaii.

The HF-1000 without its preamp had about the same sensitivity as the RA-6790. (JG)

STABILITY

All fixed local oscillator frequencies and critical timing signals in the receiver are derived from a 10-MHz reference oscillator. The latter can be locked to an external oscillator's input of 1, 2, 5 or 10 MHz. The internal reference oscillator's stability is stated to be better than 1 part per million.

A convenient way for checking stability of a receiver like the HF-1000, with its single reference oscillator and precise BFO zero-setting capability, is to tune to WWV in the CW mode with BFO set at zero, find the exact frequency of zero-beat, and note any change in the frequency over time. I noticed no evident change in the zero-beat frequency, although this wasn't continually checked.

At 15 MHz, I found the oscillator in our HF-1000 to be off slightly, as indicated by zero beat for WWV. I registered zero beat at 15.000015 MHz.This suggested a 10 Hz error in the setting of the 10 MHz reference oscillator. There is normally a trimmer in such a receiver for making very small corrections to the oscillator's frequency, but I haven't noticed it mentioned in the manual. (JG)

DYNAMIC RANGE

Watkins-Johnson claims "High Dynamic Range: +30 dBm 3rd-order intercept typical." In the Manual, the company expands on this by stating the 3rd-order intercept point to be "+30 dBm typical, +25 dBm minimum (for signals separated by 20 kHz minimum)." Unfortunately, the measurement bandwidth is unstated.

Elton ('Bi') Byington commented on an article entitled "Key Components of Modern Receiver Design" by Dr. Ulrich L. Rohde, the first part of which appeared in the May 1994 issue of QST. Bi cited one feature of the HF-1000's design that would contribute to good dynamic range:

> *Rohde's argument centers around a receiver's AGC design and how it impacts on the set's dynamic range. He contends most modern radios are susceptible to intermodulation distortion because they derive their only AGC voltage from a point beyond their 2nd IF.*
>
> *In the article, Rohde argues persuasively for a two-section AGC system - one part controlling the 2nd IF's gain in a traditional manner, the other part controlling the gain of the first IF and the receiver's front end. His point is that intermodulation distortion can be produced at the set's 2nd mixer - and hence in the radio's second IF without its components having any effect. The argument is quite persuasive.*
>
> *Only two receivers I know of limit the gain of the first IF from a signal derived from the first IF itself: the Lowe HF-225 and the W-J HF-1000. Lowe uses a PIN diode to limit the gain of the first IF (45 MHz); the W-J uses a controlled bipolar amplifier.*

SYNCHRONOUS AM

The upgrade for synchronous AM was issued after our receiver try-out. It is of the double-sideband type. A W-J spokesman tells us that the pros and cons of double sideband and selectable sideband have been considered, and it is probable a future synchronous AM system will be of the selectable sideband type. We certainly endorse such a move.

PARAMETER	NRD + ESKA	HF-1000 + SAM
Weak signal lock range	+/- 20 Hz	+/- 250 Hz
Strong signal lock range	+/- 40 Hz	+/- 900 Hz

The following comment on the signal-lock performance of the present system was posted on Internet:

> *This past week I received the firmware for installing Synchronous AM (SAM) detection in my HF-1000 receiver. I was able to install it in about half an hour and it worked great. In testing it I compared it to the ESKA phase-lock AM board installed in my NRD-525. Here are the results for strong and weak signals.*
>
> *As an on-the-air test I tried to lock onto Radio Pyongyang, 13760 kHz, at 1300 UTC. The signal was weak and fading rapidly and was (actually) on 13760.1 kHz.The HF-1000 was able to lock onto it immediately even when set to 13760.000. The NRD was not able to lock it at all, even when set to 13760.1. Impressive!*- John Reed, KA5QEP

GAIN CONTROL MODES

Our test receiver had the standard control mode options available; Manual, AGC Fast and AGC Slow. The spec sheet's figure for typical attack time was 15 msec and for fast decay time, 25 msec. The slow decay rate was not specified.

Further specifications were: AGC range 100 dB minimum; Manual range greater than 100 dB. The AGC threshold was said to vary with bandwidth and was typically 10 dB above noise floor, being .56 microvolt for a 6 kHz width and .12 microvolt for a 300 Hz width.

Since our receiver try-out, Watkins-Johnson has released a firmware upgrade that provides a third AGC decay rate - Medium, an adjustable AGC-threshold mode in addition to the relatively fixed AGC threshold described above, and adjustable AGC-decay time. The following comment was posted on CompuServe:

AGC SETTING	DEFAULT DECAY TIME	RANGE LIMITS (USER-SELECTABLE)
FAST	20 msec	10-100 msec
MEDIUM	200 msec	100 msec - 1 sec
SLOW	2 sec	1 sec - 5 sec

It's interesting, and certainly more than a coincidence, that the HF-1000's AGC setup is now similar to the Racal 6790/GM - fast, medium, slow, manual, and fixed or adjustable threshold. I think you'll find that there's enough variation here to compensate for almost any signal condition you'll encounter.
- Steve Share

The HF-1000's upgrade, however, takes AGC flexibility farther than that in the Racal, a receiver whose design is about 15 years old.The HF-1000 owner can program in an AGC-decay time for each of three settings.The attack time of 15 msec is said to be unchanged.The decay times are as follows:

PASSBAND TUNING

This feature is limited to use while the receiver is in the CW mode and allows for a +/- 2 kHz shift relative to the passband. W-J has indicated a future upgrade will make available passband tuning in the SSB mode. The maximum shift will be increased for SSB, but we are told the exact limits have not yet been set.

TUNABLE IF NOTCH FILTER

In our test HF-1000, the filter appeared to be sufficiently deep for removing a strong heterodyne. The notch depth is said to be typically in excess of 60 dB. This is an impressive number, comparing favourably with the best IF notch arrangements in some earlier Drake, Collins and Hammarlund receivers of the past.

The function operates in the AM, FM, USB, LSB and ISB modes. The notch nominally can be adjusted +/- 9999 Hz relative to the tuned carrier frequency, although the actual tuning limits become progressively narrower as the bandwidth is narrowed. Either the Auxiliary Parameter edit knob or the numeric entry keys can be used to vary the relative notch frequency.

BFO FREQUENCY ENTRY

When the receiver is in the CW detection mode, the BFO entry key in the Auxiliary Parameter section can be activated to allow adjustment of the BFO frequency to anything within the range of +/ - 8000 Hz. Entry is made by the numeric entry keys or by adjustment of the Auxiliary Parameter edit knob. The ability to call into use a precise BFO frequency is especially useful for RTTY because the various frequency shifts that may be employed each call for a specific BFO frequency for best reception.

Repeated pressings of the +/- Zero Key cycle through three positions, either setting the existing BFO frequency above or below the carrier frequency, or setting the BFO frequency to zero.

SIGNAL LEVEL METER

The analog meter indicates signal strength both in 'S' units and in dBm (decibels referenced to 1 milliwatt). The scale range is -120 to +10 dBm, with the maximum on the 'S' scale being 80 dB over S9. The meter calibration is not affected by switching in either the preamplifier or the RF attenuator.

MEMORY CHANNELS

The HF-1000 has a capacity of 100 memories, or memory channels, as the manufacturer calls them. Memory backup is provided by an easily replaceable lithium battery.

To store a currently tuned frequency and other receiver parameters, it is a simple matter of first pressing the Channel View key on the left side of the front panel. Then, either the Memory/Scan edit knob or a numeric key entry for a particular channel, will bring the channel number and any existing frequency entered in the channel to the Memory/ Scan display. Once the desired memory channel is displayed, the user presses the Store Key to place the tuned frequency and other parameters into that memory.

For the reverse procedure, changing receiver parameters to those stored in a memory channel, the same steps are performed; pressing the Channel View key and using either the edit knob or a numeric key entry to bring up the memory channel to the display. Pressing the Channel Execute key updates the receiver with the parameters from the memory channel.

SCAN MODE

Three types of scan operations are available - memory channel scanning, frequency-to-frequency scanning, and frequency-to-frequency scanning with lockout frequencies inserted. For this latter type, the number of frequencies locked out can range in number up to 100.I n frequency-to-frequency scanning, the choice of frequency increment is within the range of 1 Hz to 25 kHz.

A Dwell key is used to set the time the receiver will pause at a signal before moving on. The time length can be from .5 to 20 seconds in duration or it can be infinite, i.e. until either the signal drops below the user-adjustable squelch threshold for 8 seconds, or the operator restarts the scan.

The first review of the HF-1000 in the commerical press that we are aware of appeared in the June 1994 issue of the British publication, *Short Wave Magazine.* The reviewer, Mike Richards, was especially enthused with the flexibility of the frequency scan mode for hunting down utility signals. Ease of use of the scanning modes also received high marks thanks to the user prompts in the menu system provided through the auxiliary displays.

BUILT-IN-TEST FUNCTION

The Built-in Test Function, or BITE, permits testing the internal circuitry of the receiver. A successful BITE test provides confidence that the receiver is performing normally. BITE is accessed and started with the Special Function key. Sixteen tests are performed.If all are successful, 'Bite Pass' is displayed; otherwise, a failure of any individual test registers as a specific number in the display. The meaning of each error code is described in the Manual.

AUDIO

The audio is clear and of good quality, although the *Short Wave Magazine* reviewer was somewhat disappointed with the measured distortion level through the speaker and headphone outputs. There are internal and external speaker, headphone and line outputs as follows:

> **Speaker**: Level adjustable up to 1 watt into 8 ohms, with a bandwidth 100 Hz to 13 kHz, +/- 2 dB.
> **Headphone:** Level adjustable up to 10 mW into 600 ohms; ¼ in. stereo jack. (This is an ideal match for the Japan Radio ST-3 communications phones used by many DXers.) Two unbalanced outputs with channelsfor USB and LSB in ISB mode; otherwise, outputs are combined.
> **Line:** Level 0 dBm, or 1 mW, into 600 ohms. Two balanced outputs with channels for USB and LSB in ISB mode; otherwise, outputs are combined.

Bill Bowers pointed out to us that the internal speaker is not muted, even if the headphone jack is engaged or the external speaker connections are used. Since there are seperate speaker and headphone volume controls, this is not a problem when using headphones, provided the speaker volume is set at minimum output. However, the single speaker volume control governs the audio level for both the internal speaker and the external speaker outputs. This oversight interferes with the usefulness of adding a better quality external speaker.

Another convenience shortcoming is the absence of a tape recorder output although the 600 ohm line output works well for this purpose.

POWER SUPPLY

The receiver will automatically adjust to a connected power supply that is in the permissible range of 97 to 253 volts AC, 47 to 440 Hz. The power consumption with receiver options included is typically 35 watts. DC operation is not available.

RS-232 REMOTE OPERATION

The receiver can be controlled remotely by a computer or other controller device that is equipped with an RS-232 serial interface and capable of transmitting and receiving ASCII-standard encoded characters. Physically, only a transmit, a receive and a ground line are needed between controller and receiver. Twenty-nine different receiver parameters, ordinarily under local operator control, can be controlled or monitored over the RS-232 interface. There are 28 pages in the Manual explaining this form of remote operation.

CSMA REMOTE CONTROL

An alternate method of remote control, probably of much less interest among radio hobbyists, is through another interface type; Carrier Sense/Multiple Access with Collision Detection, or CSMA for short. This is a media access method whereby a number of stations, from 2 to 63, share a common line or bus medium. Eight receiver parameters can be remotely controlled.The Manual devotes a further 15 pages to this system.

REAR-PANEL CONNECTORS

On the rear panel are the following connectors:

Individual BNC connectors for RF input, HF-1000/PRE preselector input and output, signal monitor output,post-filtered IF output, reference oscillator input.
Mini-phone jack as CSMA remote interface port.
D-25 as RS-232C remote serial interface port.
D-15 for two 600-ohm audio line outputs, DC-coupled audio output, speaker output, remote signal strengthindication ouput, squelch output and mute input.
Grounded (three-prong) male receptacle for line cord.

The D-15 multi-pin plug is most inconvenient. The specifications pages in the Manual and the text in the marketing brochure indicates these outputs are provided by terminal strip (ie. screw terminals). That's what should have been provided but it isn't!

RF INTERFERENCE FROM DISPLAYS

Bill Bowers has performed some tests to measure the relative noise at mediumwave (812.7 kHz) and the 90 meter Tropical Band (3127 kHz) frequencies emitted by the digital displays of the HF-1000 and several other receivers. A Sony ICF-2010 (with 24 inch whip, in AM mode at wide selectivity and RF at maximum) was placed progressively farther away from the front face of each receiver to determine the distances in inches at which the Sony's signal-strength LED's went out (test #1) and further, when even the slightest audio noise ceased to be detectable (test #2).

In the following chart, lines one and two show the results of test #1 and test #2 respectively on Medium Wave for the subject receivers. Lines three and four correspondingly show the results of test #1 and test #2 on Tropical Band.

TEST	RA-6790	R-9000	R8	NRD-535	HF-1000
MW #1	8"	14"	1"	23"	17"
MW #2	21"	27"	4"	37"	23"
SW #1	4"	5"	0"	10"	11"
SW #2	13"	15"	4"	21"	16"

The clear winner in both tests on both frequencies is the Drake R8. Generally speaking, the Racal RA-6790 ranks 2nd. The HF-1000 and the Icom R-9000 can be seen to be in a close race for 3rd ranking, while the Japan Radio NRD-535 is slightly inferior still.

These tests should be taken into consideration by anyone considering using a loop antenna in the immediate proximity of the receiver, or indeed any form of antennae with unshielded lead-in.

Using at first an unshielded antenna lead-in, I thought the noise (radiated by the receiver and picked up by the antenna lead-in) from the HF-1000's displays was very low in both the AM broadcast band and in the shortwave spectrum up to about 11 MHz. It was from there to 30 MHz that the noise gradually increased, to the point where it exceeded weak signals. It seems necessary for any tuning in the higher frequencies to have a coax lead-in from an antenna. A W-J engineer told me they had had no indication at present that display noise is a particular problem. (JG)

My experience at my urban residence with an unshielded random wire was the same as James: severe hash was received at 10 MHz. It became progressively worse as the frequency increased. Furthermore, the blinking cursor associated with the frequency display was easily detectable at almost the same speed as the beat tones of WWV on 5 MHz. Perhaps there was some form of shielding fault specific to our test receiver? I should add, however, that none of these noise problems was experienced using coaxially-fed Beverage antennas at the DX barn on my rural property.(DC)

POSSIBLE FUTURE ENHANCEMENTS

Watkins-Johnson has confirmed the following enhancements are under consideration:

FSK Demodulation: This additional capability could be either an internal or outboard enhancement

Additional SSB bandwidths: Some owners have requested that the maximum IF bandwidth in the SSB modebe higher than the current limit of 3.2 kHz. The limit may simply be removed, making any width of up to 8kHz available for SSB use.

PC Signal Monitor: output for computer RF spectrum displays.

Adaptive audio filtering for automatic notching out of multiple heterodynes and for wideband "white noise"reduction. This would seem to be a "natural" for extension of the inherent DSP capabilities, to incorporate some of the features now provided by accessory units such as the NIR-10 and units in the line of DSP filtersfrom JPS Communications.

Speech compression for remote operation by modem.

We have been told that any of the last three enhancements may come about either by using the current DSP chip or an additional one. The capacity of the current chip is almost fully utilized but if the hobby community has little use for the reconstructed analog 455 kHz output, its removal could free up some capacity and permit an upgrade of the present chip to accomodate these changes. This approach would avoid having to put an additional daughter-board in the receiver, an alternative that could cost at least $700.

HF-1000/PRE: SUBOCTAVE PRESELECTOR OPTION

This optional filter device mounts inside the rear wall of the receiver's chassis. The preselector filters unwanted out-of-band energy from the RF applied to the receiver and therefore might be a worthy addition for anyone operating from an especially high signal level environment.

Each one of eleven filters covers a part of the RF spectrum in the range of 0 MHz to 30 MHz. The receiver's tuned frequency determines the selection of the appropriate filter which improves the receiver's second and third intercept performance. The preselector also features two RF voltage overload-protection circuits.

CONCLUSION

Our early impression is that the HF-1000 is a worthy purchase for the well-heeled hobbyist who must have the "latest and greatest", especially given the enhancements added since our test. In side-by-side comparisons with James' RA-6790 and David's R8, however, we found no significant differences in tough-signal "DX-ability", except for utility modes. Certainly the array of IF filters with their outstanding skirt selectivity characteristics is a major advance. But from a DXer's perspective, similar reception capabilities can be attained from other "conventional" top-end receivers like the NRD-535D and the R8, albeit sometimes with a bit more "knob twiddling". The value for the current pricetag of the HF-1000 is debatable. We would like to think that as has been the case with most new and emerging technologies, the price of DSP chips could come down significantly. It might be worth a wait.

On the other hand, we hope the HF-1000 continues to sell well as it apparently is. It would be a pity if a quality outfit like Watkins-Johnson was discouraged from developing a presence in the hobby marketplace. W-J has already established a good reputation for its interest in and responsiveness to user feedback, so all indications are very positive.

Universal Radio in Reynoldsburg, Ohio quotes the HF-1000 at $3,799. The optional preselector is priced at $599.95. In Canada, Norham Radio in Toronto, Ontario quoted the Canadian funds price at $5,200 based on the prevailing exchange rate for the US dollar. A Canadians funds price for the preselector was not available.

UPDATE:

MORE ON THE WATKINS-JOHNSON HF-1000 RECEIVER

(Current Version as of August, 1994)

Submitted by: **George Zeller** Compiled by: **David Clark**

Editor's Note: *The appearance of the HF-1000 in the fall of 1993 caused such a stir in the marketplace that we resolved to provide an "early" review in this issue of Proceedings. The preceding article by David Clark and James Goodwin was necessarily captioned a "first impressions" review. In late-winter 1994, they had time-limited use of an early version HF-1000 on loan from the Canadian dealer. Since then, e-prom upgrades have been implemented which enhanced the AGC capabilities and delivered the planned synchronous AM capability.*

In midsummer 1994, George Zeller acquired a new HF-1000 which incorporated all of the more recent e-prom upgrades. He also purchased the optional preselector to ensure optimal front-end performance. Just before Proceedings 1994-95 was going to press, George informally shared his more extensive findings and insights with us, including perspectives based on his own direct dialogue with Watkins-Johnson. The editorial staff are grateful for George's authorization to compile this timely and highly useful Update for inclusion in this edition.

OVERVIEW

Let's begin with two very important statements. First, I believe this receiver dramatically outclasses every other receiver in the consumer shortwave radio marketplace, regardless of price. I am absolutely delighted with it so far! I want to emphasize that the relatively few problems I have identified and my suggestions for improvements should not be construed as detracting from my overall enthusiasm for the product.

Second, Watkins-Johnson is to be commended for their open policy of communication with their customers. When I called the '800' number, I was treated in a very friendly fashion while Michael Cox of the W-J Engineering Department was on another line. I then enjoyed a half-hour conversation with Mr. Cox who was very friendly and helpful. I have since sent him a lengthy letter which outlines my findings and recommendations based on the month or so of experience that I have had with the receiver. I am confident I can anticipate a constructive response in due course.

My comments begin by highlighting just some of the many outstanding features of the HF-1000. Then I outline the more significant deficiencies or shortcomings that I have found. These findings form the basis of a longer "wish list" of suggestions for future upgrades. I believe these suggestions merit and probably will receive serious consideration by W-J. Finally, I have compiled a list of further "nice-to-have" enhancements that may not be feasible to implement based on practical memory limitations and/or the physical design of the HF-1000.

OUTSTANDING FEATURES

Any discussion of the HF-1000 must start with the 58 IF filters which all seem to have nearly vertical shape factors. These DSP-derived filters are the principle technological breakthrough that places the HF-1000 in a class by itself.

But there are other unique features that deserve strong kudos. The BFO, Notch, and Step Tune are adjustable to a resolution as fine as 1 Hz, with corresponding readout on the front panel display. The frequency readout is available to 1 Hz resolution as well. The PBT is adjustable to 10 Hz resolution although it is only operative in CW mode. The threshold levels of the three AGC positions (plus Off) are adjustable as well. The ten-position Noise Blanker is very effective. No other receiver has this combination of features and flexibility. They are wonderful.

The general performance of the receiver is better than I have experienced with any other radio. The sensitivity is very good and has been found to be better than the ICOM R-9000 is some 'A-B' tests I did with a single antenna. The front end seems to be built like a battleship. I do have the optional preselector installed and have not noticed any stray signals. Dynamic range and blocking seem superior to other receivers I have used. The acid test for me is the nightly situation on 7415 kHz which I tune for pirate DXing purposes. When WEWN signs on 7425 kHz with its very powerful 500 kW signal and broadband slop, my other receivers can't handle the mess. I can get rid of WEWN on 7415 kHz entirely in LSB mode with the HF-1000.

The memories are all tunable and you can tune between the memories with a knob. This is a very useful feature that I haven't seen on other current receivers except the Japan Radio NRD-535D. The Drake R8 tunes between the memories but the memories themselves are not tunable.

The layout of the front panel is pretty good. It didn't take too long to learn how everything works and general ergonomics are good. Functions and displays are spread out over a lot of space, so you really can't push the wrong buttons by mistake. The owner's manual is extremely good. It is clearly written, comprehensive and includes schematics, parts list and computer control parameters. The General Binding spiral binder is good for adding future manual update pages.

I think the audio is very good, especially in the AM synchronous mode which is the latest software upgrade and has been implemented in the model I purchased. Audio is better than that of the R-9000 which is also very good. It rivals the audio quality delivered by the Philips DC-777 shortwave car radio which, in my opinion, has the best audio of any current shortwave receiver. This seems to be mainly a result of the filter flexibility and the synchronous detector, although audio is quite good in single sideband mode too. I will modify this assessment with later remarks concerning audio hiss and the internal speaker that cannot be disabled.

Taken collectively, all of these flexible features and functions mean that there is no better shortwave receiver currently for sale, although it certainly is expensive. I don't believe any other receiver even approaches the level of capability of the HF-1000. It is a great technological breakthrough in useful DX performance. In fact, I am running out of adjectives to describe its literally astonishing overall performance characteristics.

THE BAD NEWS

Aside from the enormous price-tag which unfortunately places prospective ownership of the receiver beyond a large majority in the shortwave receiver consumer market, I have identified five aspects that I feel can be classified as definite flaws, although only one is really serious. Of these, the first four are problematic, so I do hope W-J will give some thought to fixes, most importantly with respect to the digital hash characteristic that David Clark and James Goodwin identified in their review. The fifth flaw is less salient but nevertheless, it is a problem.

1. **DIGITAL HASH:** The receiver puts out a very unfortunate level of digital computer hash noise. It seems to come from the front panel but W-J says that their probes indicate the problem may originate with the e-prom that drives the front panel. The condition makes it difficult to use an indoor medium wave loop antenna such as the Kiwa model that I have in the immediate proximity of the receiver. It also creates serious shielding problems for feedlines from outside antennas (see also 3. following). Although evidence of the hash is certainly a concern on the lower frequencies, I should add that it is much worse on frequencies above 12 MHz.

This is the worst fault with the HF-1000 by far...the one really significant blemish on an otherwise super receiver. If the problem indeed lies with the e-prom, this might just be a question of providing improved shielding.

2. **SOFTWARE FAILURE:** On one occasion the memories suddenly went dead and after a couple of minutes, the entire receiver seized up. A strange 26 MHz frequency appeared on the display but otherwise, all other panel indicators were frozen in the initialization mode. No knobs or buttons worked and there was no audio output. Turning the receiver off and then on again started a new initialization cycle (analogous to a "soft boot" on a computer) which terminated in the same frozen condition.

Fortunately there is a cold start ("hard boot") mode programmed into the receiver software. This is invoked by depressing the Clear/Entry key at the same time the receiver is powered on. When this was invoked, normal operation resumed, except that all memories and other settings were not retained. The receiver returned to default mode as it comes out of the box. Apart from this one incident, it has worked perfectly ever since. The sequence of events has been communicated to W-J and their diagnosis is hopefully going to identify and resolve the presumed software bug.

3. **BIRDIES:** In normal use, I find there are dozens of birdies in the receiver. The worst of them are concentrated in or near the 20 meter ham band and the 31 meter SWBC band. The birdies sound like the digital hash and are present in two categories; those which are extremely strong and others which are not as strong but still very noticeable. The extremely strong ones have been found at 3500, 8000, 11200, 11400, 12400, 12800, 13200, 14000, 14400, 14800, 16000, 17600, 24000, 28000 and 30000 kHz. The other audibly bothersome group have been located at 7000, 10800, 11500, 11600, 11700, 11800, 11900, 12000, 12500, 12600, 12700, 13000, 13100, 13300, 13500, 13600, 13800, 13900, 14300, 14500, 14600, 14700 and 18000 kHz.

There is a significant difference between the two categories. The extremely strong birdies are audible, albeit weaker, when no antenna is connected. The second category disappear when the antenna is disconnected but reappear when the antenna is again connected to the receiver. So it seems that the birdies are a by-product of the digital hash which is apparently being reradiated into the receiver, even through a coaxial antenna lead-in. A better internal shielding arrangement is an imperative.

4. **AUDIO HISS:** It is strange that the HF-1000 exhibits two of the problems that plagued the Japan Radio NRD-525; digital hash and hiss noise in the audio output. The hiss is not nearly as bad in the HF-1000 but it is nonetheless audibly noticeable and distracting, especially when using headphones. The level seems to be related to the filter in use; the hiss is more bothersome when a wider filter is used.

While the fault is not nearly as serious as the digital hash interference, it is something to be concerned about. The addition of a DSP audio processor ought to resolve this annoying problem.

5. **AUDIO 'OUT' IDIOSYNCRASIES:** The multipurpose A2J16 pin output is utterly nonstandard in the radio hobby. Fortunately, I spotted this before I purchased the receiver from Universal Shortwave. They soldered some connectors to the pin plug for me. I now have two RCA jacks for the USB/LSB/ISB audio out. I also have the external speaker audio out wired to a 1/4" plug which in my case is used to drive an M-8000 RTTY decoder.

The audio through the small, internal speaker is quite poor. I was then annoyed to find that the audio to this speaker cannot be disabled, even when an external speaker is engaged.

The independent AF gain control for the headphones is a very nice touch, although here the adjustment range of the gain control could be improved; it has to be turned up well-past the halfway point before adequate volume is received through the headphones.

UPGRADES NEEDED - WISH LIST

It is understood that the memory capacity on the present DSP chip is almost exhausted. This means that in the absence of, or pending an expensive ($700-1000 range) major upgrade, some software upgrades might have to come at the expense of removing some of the existing features. I have a few observations in this regard.

I am not using the IF out provision so I probably wouldn't miss it unless it was to be used for an external spectrum display. I do find the "false stereo" effect of the ISB mode on an AM signal to be an interesting novelty. In some cases it seems to provide the most usable copy of a DX signal so I would be reluctant to lose that mode.

If a proposed selectable sideband AM synchronous detector works as well as the present double-sideband version, then I would be interested. But if that degraded the wonderful audio delivered by the current implementation, then I would certainly not want to lose it. I understand as well from talking with W-J that expanding the range of filters available for SSB mode would consume significant additional memory.

Taking these caveats into account, as well as the more serious problems I have identified, following is my current wish list of needed and strongly recommended upgrades.

1. **Fix the Digital Hash:** Since this is the only really serious problem with the receiver, improved shielding or other modifications to deal with it should be the number one priority. My experience indicates that if this was to be resolved, the numerous strong birdies would be greatly attenuated as well.

2. **Provide DSP Audio Processing:** It is understood that provision has been made for the future extension of DSP to the audio stage. This would seem to be a "natural" for expansion of the already impressive DSP utilization. It ought to be a significant improvement since it would surely eliminate the hiss noise currently noticeable in the audio output.

3. **Enable PBT in Sideband Modes:** I can't understand why the PBT only functions in CW mode. Many DXers, including myself, frequently do a lot of tuning and DX listening in sideband modes, including ECSS reception of AM signals. PBT is often useful for interference rejection and often obviates the need for a filter that is too narrow for reasonable audio reproduction. For this proposed implementation, the present PBT tuning range (+/- 2 kHz) should be expanded to +/- 3 or 4 kHz.

4. **Enable Wider Filters in Sideband Modes:** It seems strange that AM and CW can be received at any filter bandwidth, yet SSB reception is limited to the filters within the range of .9 to 3.2 kHz. It is recognized that a 3.2 sideband bandwidth renders about as much audio as a 6 kHz filter in AM mode, but expanded provision for filters wider than 3.2 kHz would still be desirable, especially when toggling between AM sync and SSB modes.

5. **Provide Selectable Sideband AM Synchronous Mode:** As noted, there are times when user-selectable upper or lower sideband selection is desirable for optimum ECSS reception. The present double sideband implementation, as provided for example in the Lowe HF-225/Europa, should be retained if possible. Maximum flexibility would be great if provision could be made for selectable sideband as well, as has been implemented for example in the Lowe HF-150.

6. **Resolve Audio Out Deficiencies:** There are four issues here. The pin connector should be replaced with a terminal strip or by providing of an adaptor that allows an array of pre-wired RCA audio jack outputs to be plugged into the connector. Next, the internal speaker should be automatically disengaged (or switch selectable) when the external speaker out is connected. Improve the "balance" across the range of the headphone volume control. Finally, the front panel switch to regulate 'USB/LSB/ISB Out' only affects the audio output to the external speaker output via the connector. It doesn't work with either the headphones or the internal speaker. Given that my external speaker out is used for the RTTY reader, I get no use at all from the switch as currently configured.

IT WOULD BE NICE...

Here are other items on my current "wish list", although these are mostly in the convenience improvement category, some probably limited by the front panel design, and certainly noncritical to the performance of the receiver.

1. Spectrum Display: I find a valuable feature of the ICOM R-9000 is its very user friendly and virtually real time spectrum display. As there is no built-in CRT display in the HF-1000, I suppose any spectrum analysis capability would need to be handled by an outboard device via the IF out.

2. Programmable Alpha-Numeric Memory Designations: A number of receivers, including portables such as the Sony SW-55 & 77 and certain Grundig models, allow the user to program an alphanumeric designation for each memory channel. This would be a convenient addition to the HF-1000's capabilities but I'm not sure how display might be handled on the front panel.

3. Another 100 Memories: Like the Drake R8, the HF-1000 only provides capacity for 100 memories. Many of the better receivers today provide 200 or more memory channels. The addition of another 100 (tunable) memories would be useful for some owners, especially those who like to take advantage of the complementary scanning functions.

4. Mode Buttons: Most users are very annoyed by carousel-style mode change buttons. The worst offender in this regard is the Drake R8. At least with the HF-1000, the carousel is bidirectional so it is relatively easy to toggle back and forth between the USB and LSB modes but the design is inconvenient for invoking offsets in CW, RTTY and FAX modes. The ICOM R-9000 arrangement of individual buttons for each mode is a superior design but I don't know where individual mode selection buttons would go on the existing HF-1000 front panel.

5. Keypad Format: The familiar touch-tone telephone keypad sequential numeric format with zero and other entry functions on the lowest row is provided on most shortwave receivers which provide keypad entry facilities. The inverted format of the HF-1000 keypad takes some getting used to. Is this a leftover from a military or commercial standard?

6. Improved Smoothness for the Main Tuning Knob: The feel of the main tuning knob "wheel", as it is dubbed in the Owner's Manual, is quite stiff. This may seem minor but during long DXing sessions, a comfortable feel such as that rendered by the Drake R8 is important. Using the big knob on the HF-1000 feels like turning the main wheel on an ocean liner. Maybe it needs a dose of power steering!

7. S-unit Conversion: The dBm calibration on the signal strength meter is interesting, seems precise, and fortunately is precisely correlated with the dBm units governing the Squelch control. But this unit of measurement is non-standard in the radio hobby. Most other good receivers contain S-meters or equivalent graphical displays that are calibrated in S-units and decibels over S-9. Apart from converting to an S-meter, a simple conversion chart defining equivalent S-units in microvolts that could be inserted into the Owner's Manual would be a valuable "no cost" service to most purchasers.

PRE-WAR CONSOLE RADIOS AN SWL'S DELIGHT

John Bryant

Many SWBC DXers of the 1930s used consumer grade "console" radios for DXing as well as program listening. This was probably due to the rarity and cost of most communications receivers of that era. Many current hobbyists first heard shortwave broadcasts on the family console, as well. As my own interest in the history of radio matured, I became very curious about the possibility of using one of these old giants as a modern SWL receiver. After seeing numerous consoles at several vintage radio auctions, I also came to appreciate their beauty as major pieces of furniture. This interest led to a good deal of research, primarily related to Zenith consoles, and to my eventual purchase of two beauties from the pre-War era. My experience with all-wave consoles has been so enjoyable that I want to encourage others to acquire one.

BACKGROUND

Prior to the modern era of mass produced 'consumer products', artisans hand-crafted the furniture, carriages, clothing and possessions of the wealthy. As mass production began to make household goods available to the emerging middle class in the 1920's, these new 'consumer' products were generally either relatively poor copies of ornate hand-crafted objects or strictly utilitarian in appearance. Many new products maintained the appearance of the technologically obsolete objects that they superseded. For instance, in the early years, automobiles (horseless carriages) were almost exact copies of the carriages of the wealthy. In fact, carriage and buggy design aesthetics dominated most of automotive styling until the early 1930's.

The styling trends in radios, the most popular of the new products of mass production, closely paralleled those of other consumer goods of the day. The earliest home radios looked very much like the laboratory instruments or engineer's breadboard prototypes that they so recently were. By the late 1920s, these very utilitarian radios became wildly popular and the family radio became the centerpiece of many middle class living rooms. Quite naturally, there was then pressure to upgrade the utilitarian appearance of most radios. The new styling trends of these 1920's receivers seem predictable from this perspective: chameleon-like, they very quickly took on the appearance of major pieces of living room furniture. The "radio as furniture" trend was accelerated in the mid 1920's when tubes were developed which could be run on AC house circuits rather than messy storage batteries. Receiver chassis were placed in ornate tables, in side tables, credenzas and desks. Zenith advertising in the late 1920s and throughout the 1930s spoke of their wooden cabinets as:

"... the finest example of the furniture makers art with the finest of veneers. You are assured of the finest furniture in durability, excellence of woods, beauty of design and acoustical perfection. ... A Zenith owner is always justly proud of Zenith furniture."

This early marriage of ornate hand-crafted furniture and electronics led rather logically to the major console radios (former armoire) of the 1930's and 40's. (Figure 1) Console radios became very popular in the latter

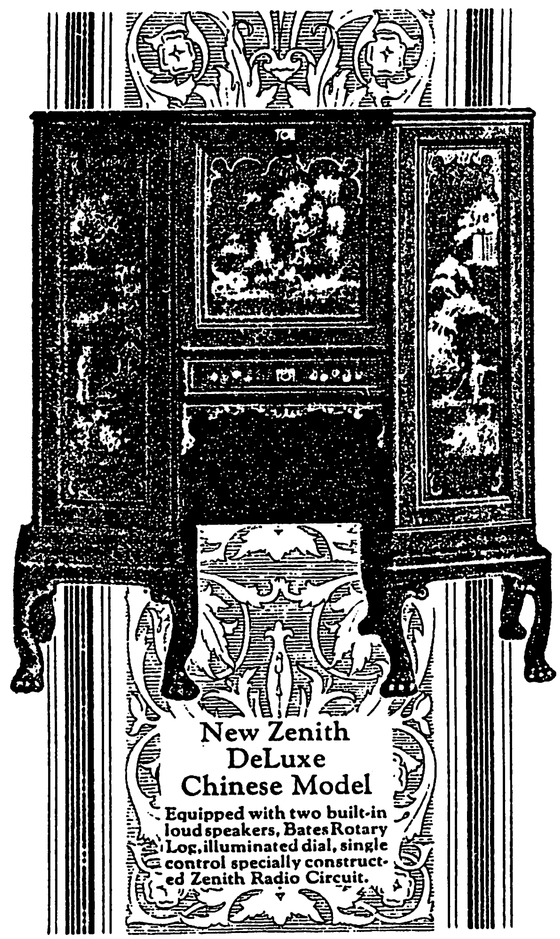


Figure 1. 1926 Zenith Console which sold for $2000!

1930s. The main advantage of consoles over table models was that the entire lower area of the console cabinet could become an enclosure for a very large speaker. Some Top-of-the-Line consoles even sported multiple speakers. Most mid-priced consoles offered audio amplifiers so powerful that they could cause real pain if run at anything like full volume. In fact, many Top-of-the-Line consoles were actually purchased to provide music in ballrooms and dance halls rather than for home use.

The popularity of consoles occurred almost simultaneously with the development of international broadcasting on shortwave and America's growing concern over European and Asian conflicts. As interest in international affairs and broadcasting increased, the American electronics industry responded with very sophisticated console radios.

AT THE ZENITH RADIO COMPANY

Commander Eugene F. McDonald, the genius behind Zenith, was a dedicated internationalist who played a key role in the adoption of shortwave frequencies for long distance communication in the mid-1920's. Commander Mc-Donald also positioned Zenith radios at the top of the mass-produced consumer radio market. By the late 20's, Zenith was known for its excellent radios and by three slogans: "Zenith: Long Distance Radio," "Zenith's cost a little more but they do MUCH more," and the still familiar "The Quality Goes In Before the Name Goes On!" It is little wonder then, that Zenith was an industry leader in the development of both "all-wave" and console radios.

1933

Not even Zenith produced a radio that tuned significantly above 1.6 MHz before 1933. In that year, four Zenith models were introduced with a new (to Zenith, at least) dial type. The dial was a large translucent plastic disk which was parallel to but behind the front face of the receiver. A backlit portion of that disk appeared in a wedge-shaped dial escutcheon opening. As the disk rotated, the dial numbers swept past a fixed marker denoting the tuned frequency. Each of these four new radios tuned 'Foreign Broadcasts on Short Wave' as well as standard MW. There were 13 other radios in the 1933 Zenith Line, but none of them tuned shortwave.

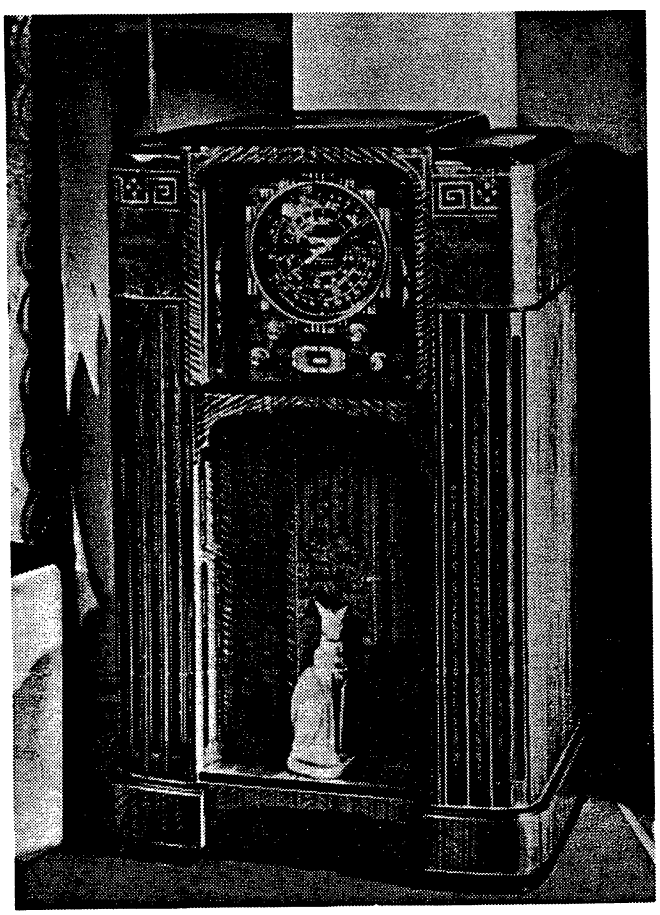


Figure 2. The Famous 25-Tube Zenith Stratosphere

1934

The real watershed Zenith model of the tube era appeared in 1934 when Zenith introduced the still revered "Zenith Stratosphere... $750 and worth it!". The Strato-sphere (Figure 2) sported 25 (!) tubes and the very first of the still famous BIG BLACK DIALs. The dial was about 10" in diameter and had an 'airplane dial' pointer mount-ed on a shaft at the center of the fixed circular dial. There were 5 concentric strips of dial markings painted on the dial. These separate strip dials denoted separate `bands' which covered from 510 kHz to 43 MHz, continuously. Along the outer edge of the dial disk were 'clock hour' markings, with 12 at the top, 6 at the bottom, etc. This was the logging scale dial that worked with a second dial pointer which ran on a gear reduced shaft from the same center of the disk as the main airplane pointer. This log-ging scale feature was soon changed to clock hour mark-ings with a 0 to 60 second scale. This new logging scale was known as "Split Second Tuning." "Amazing! NO 'GUESSWORK' TUNING WITH THE BIG BLACK DIAL."

The 1934 brochure in the Alan Jespersen's Zenith Brochure Book lists 14 models, in all, and no model ex-cept the Stratosphere mentions 'Short Wave' or 'Foreign Broadcasts.' None of the other 1934 models has a Big Black Dial, either. It is probable that the four 1933 all-wave models were continued through 1934, because there was a big change in the line coming up in 1935.

RCA also introduced several all-wave consoles in their 1934 Line.

1935

Most of the 1935 Line of Zenith radio models had fully exposed, fixed, disk-shaped dials with 'airplane' pointers just like the Stratosphere, except that these dials were only about 4" to 6" in diameter and were white rather than black. Of the 24 Zenith models in the 1935 line, all but 4 had the new round dial... the odd four were all small table models and look like hold overs from the 1934 Line, but with new model numbers.

Of the 20 round dials in the Zenith 1935 Line, 18 of them clearly tuned Short Wave and it is probable that the other 2 did as well, though the documentation on this aspect of their performance is unclear. Some of the sets covered only up to 5 MHz, others went up to 18 MHz or above. Zenith advertising featured Mussolini, the French (flyer?) Herriot and Ramsey MacDonald. There are clear records in the Zenith archives that indicate that Commander Eugene McDonald was *intensely* interested in the very unstable political situation in Europe. Apparently, so were the rest of the upper and middle class purchasers of Zenith radios.

The near total commitment of the Zenith 1935 Line to all-wave coverage is very startling, since it happened almost overnight. Zenith went from offering one all-wave set out of the 14 receivers in the 1934 line to probably 20 all-wave sets out of 23 in 1935! From casual observation at a number of radio auctions, it appears that the other manufacturers also introduced all-wave sets in 1935 or early 1936. RCA, Philco and Crosley appear to have been particularly interested in this market. However, none of these manufacturers matched the almost-total commitment to the all-wave concept made by McDonald's Zenith.

1936

By the time that the 1936 Line was introduced, most Zenith models featured a Big Black Dial which emulated the legendary Stratosphere. The 1936 dealer's brochure shows 21 radio receiver models. All but four of these models have the full-sized Big Black Dial. (Similar to Figure 3) The *only* set in the Zenith 1936 Line which did *not* cover SW was a four tube "Farm Radio."

In the 1936 Line, the 25-tube Stratosphere was joined by two 16-tube versions of the Stratosphere. These Stratospheres were three of the most beautiful consoles ever made.

1937

Zenith designers updated the Big Black Dial for most of the '37 Line models. The dial was still round, but the surrounding escutcheon was now more-or-less square with knobs located at the four corners. (Figure 3) These knobs were the On/Off, Bandswitch, Sensitivity (foreign/domestic) and Tone controls. The 1937 Big Black Dial also had "Target Tuning" which used a visual signal strength indicator similar to the well-remembered green "tuning eyes".

By 1937, all the major American radio manufacturers were providing some shortwave coverage on the majority of their radios. RCA introduced two shortwave consoles in 1937 that were unique in their commitment to international broadcast listening. The model 813K (13 tube) and Model 816K (16 tubes) each offered five 10-inch long horizontal slide rule dials. The first of these dials covered medium wave. The other four were bandspread dials, each dedicated to one of the international broadcast bands. These dials were far easier to use than even Zenith's Big Black Dials. Truly, these RCA dials were superior to those of any other radio until the digital dial era. [Review follows].

1938 AND BEYOND

The 45 or so models of the 1938 Zenith Line all had Big Black Dials. All of these radios tuned shortwave 'American and Foreign Broadcasts' except the cheapest three models. The major technical innovation at Zenith in 1938 was the introduction of the 'Robot Dial.' for console radios. This "Robot" was actually a total redesign of and successor to the Big Black Dial. The Robot Dial is what collectors today call 'the shutter dial.' This dial was still big, round and black and it still had the 'Split Second Tuning' markings around the periphery of the dial. However, that is about where the similarity to the old Big Black Dial stops. Most of the dial is actually taken up by a donut-shaped cutout. Behind the cutout are three or four pairs of half-disk shaped shutters which snap into place from left and right as the bandswitch is turned. Each pair of shutters fills the donut-shaped hole entirely and presents a single circular dial to the operator. The dial is very easy to read. The mechanics behind the dial are at least as complicated as this explanation! The introduction of the 'Robot Dial' in 1938 was, though, a clear indication of the intense level of interest in foreign broadcasts at Zenith and within the American public. Almost all 1938 Zenith console radios had the new Robot Dial. The only exception was the 25-tube Stratosphere which was again continued at The-Top-of-the-Line. Counting the 39 Robot Dial all-wave sets plus the Stratosphere these were 40 all-wave receivers out of a total of 45 radio models in the Zenith 1938 Line.

The major technical innovation in the radio industry in 1938 was the introduction of the radio-phonograph. This new product type was probably introduced as a response the increasing affluence of the American middle class and to the development of the technology for mass producing vinyl records.

Figure 3. The 1937 Big Black Dial from the Zenith catalog

In the remaining years before America entered WWII, radio-phonograph combinations came to dominate the upper end of the market and consumer interest in all-wave consoles declined. In 1938, the Zenith Line contained 19 console radio models (all tuned SW) and two radio-phonograph consoles, (both tuned SW). The 1942 Zenith Line carried only five radio consoles (all tune SW) and offered ten models of radio-phonographs (8 tuned SW).

It appeared that the production of all-wave radios and, by inference, the interest of the general public in Foreign Broadcasts, was much more extensive during the 1930s than many of us have thought. RCA, Philco and Crosley produced sets with SW capability with almost as much alacrity as Zenith. Although I have not studied these lines in detail, observation leads me to believe that at least 2/3 of the console models of 1935-1942 were all-wave. A similar ratio appears to hold for the larger table models. I am also continually surprised at the numerous small Crosley and Philco models which covered shortwave. The dials of these smaller models, however, leave much to be desired. They probably discouraged as many potential shortwave listeners in the 1930s as have the modern cheap all-wave portables now offered by many manufacturers.

The Top-of-the-Line consoles of each major manufacturer are still well regarded as shortwave radios. It is also worth noting that the almost custom made radios of the very rich and famous by manufacturers such as McMurdo Silver, Silver Marshall, Scott and Midwest were almost all MW/SW capable and are very highly regarded by those lucky few who own one today.

The Decade before America's entry into WWII was truly shortwave RADIO ACTIVE.

IN USE: THE ZENITH MODEL 12S568E (1941)

I bought this Zenith console at a vintage radio auction in Kansas City for $120 which was about half of its "book value" within the vintage radio hobby. The cabinet was nearly flawless in three dark tones of beautiful veneer. When I got it home, the radio played. However, as a precaution, I replaced all of the paper and electrolytic capacitors. Working on old consoles is usually very easy. The old deep chassis and relatively low parts counts make electronic restoration of these old war horses seem like doing plumbing work rather than electronic restoration. All of the components are *large* and widely spaced. After a brief realignment, the 12S568E took an honored place in the Bryant living room. Figure 4 is a copy of the information on the 12S568 from a 1941 Zenith salesman's pocket catalog.

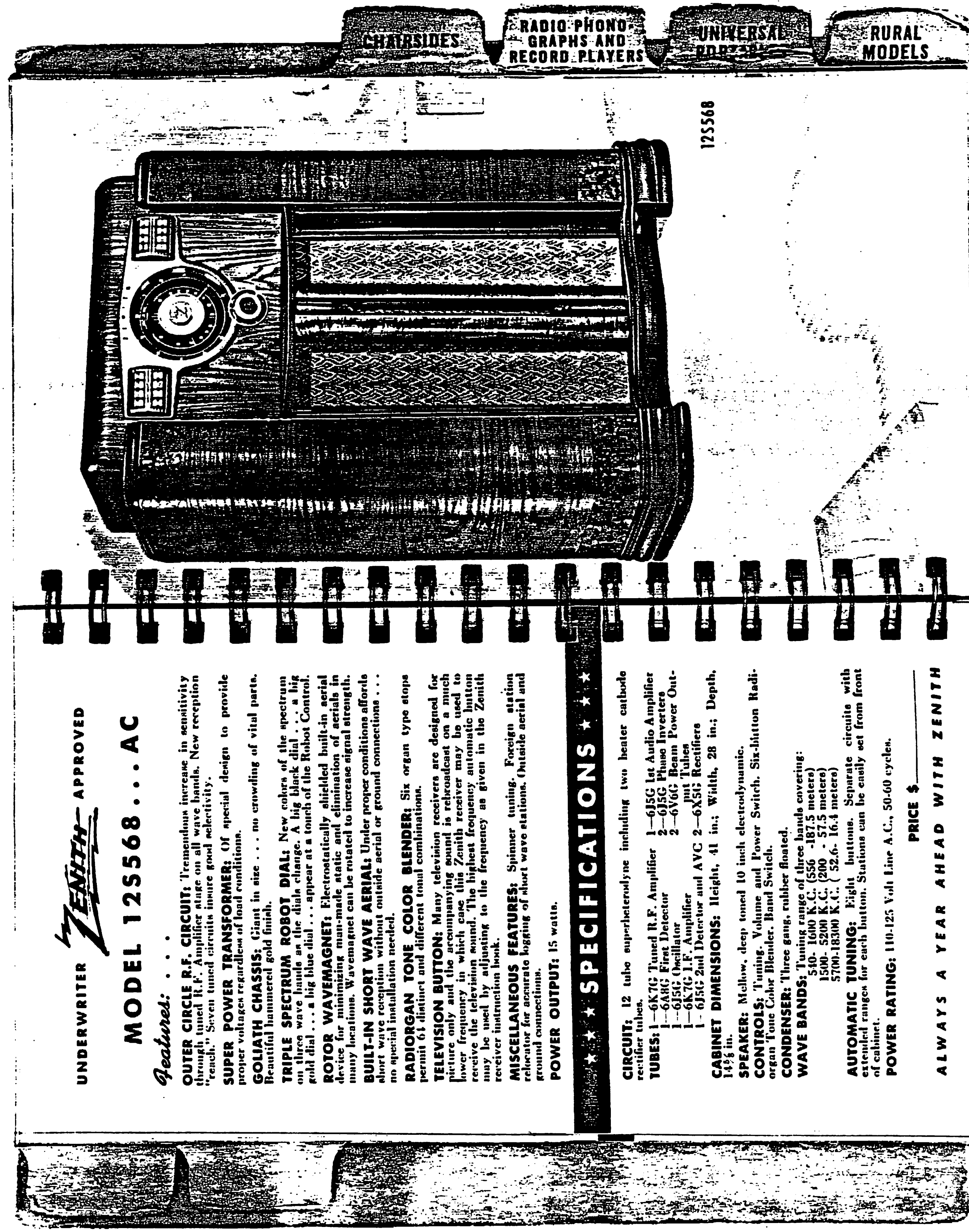
Like most Zenith consoles of that era, this one was designed to work without an external antenna. Medium wave reception is via an electrostatically shielded rotatable box loop (about 5' x 16") located behind the speaker in the lower cabinet. The shortwave antenna is a single wire loop run around the back edges of the large cabinet. Frankly, with those antennas, I didn't expect to find much on the dial. I was wrong! The medium wave and both shortwave bands were alive with signals. After a year of listening with that antenna arrangement and a few evening using a Dymek DA-100 active antenna and a Beverage, I can attest that this 12-tube 1941 console is very nearly as sensitive as most modern communications receivers. I can listen to major shortwave broadcasters on this set just as easily as my SP-600 or NRD-525!

From a modern perspective, the common weakness of all of these pre-War radios was selectivity. I do not have the instrumentation to measure selectivity and shape factor. However, the selectivity of consoles from this era seems to me to be about 6 kHz, but with very wide skirts. When the radio is centered on a strong signal, there is no background noise present and the audio range and fidelity are awesome. However, if there is a quite strong signal 5 kHz away, there will be a 5 kHz hetrodyne in the background of the audio. Neither Harold Cones, who has a 1937 Zenith 10-tuber, nor I find the selectivity to be a problem when listening to most major international broadcasters.

These consoles were designed for shortwave and to provide excellent audio. My 12S568E has a 14" diameter speaker driven by a 5-tube audio amplifier. The audio to truly awesome. The volume will blow us out of the very large two-story living room and, as you might expect, the bass response will rattle the windows. Most Zenith radios of the 1936-50 period offered tone control via an arrangement of five tone switches known collectively as the "Radiorgan." On the 12S568E, the switches are labeled from Treble to Lo Bass and may be set in a large variety of combinations. The audio of this console is so outstanding that I have installed a low power AM transmitter (available in kit form) to rebroadcast the local FM classical station at 1000 kHz on MW. I now listen to fine classical music on my 1941 Zenith Model 12S568E.

The Robot Dial and Split Second Tuning combine to make retuning a previously logged shortwave signal very easy. The gear driven "Second Hand" pointer rotates around the dial 20 times while the main dial pointer goes around once. The periphery of the dial is marked off in 60 "seconds", so a station may be logged as "5 MHz plus 40 seconds" or "7 MHz plus 23 seconds," etc. Due to the 20 to 1 gear ratio, there are 1200 "seconds" available as logging scale. On the upper SW band (5.7 to 18.3 MHz) that means that there are about 10 kHz per "Second" mark. With the radio warmed up for about five minutes before taking logging numbers, I have found retuning to a previously logged signal to be almost perfectly accurate. The dial itself is bit inaccurate at the end points. However, even there, tuning to a known but unlogged frequency of an international broadcaster is still very easy.

All, in all, the 12S568E is a wonderful addition to our home. It looks great in the living room and sounds even better!


UNDERWRITER ZENITH APPROVED

MODEL 12S568 . . . AC

Features: . . .

OUTER CIRCLE R.F. CIRCUIT: Tremendous increase in sensitivity through tuned R.F. Amplifier stage on all wave bands. New reception "reach." Seven tuned circuits insure good selectivity.

SUPER POWER TRANSFORMER: Of special design to provide proper voltages regardless of load conditions.

GOLIATH CHASSIS: Giant in size . . . no crowding of vital parts. Beautiful hammered gold finish.

TRIPLE SPECTRUM ROBOT DIAL: New colors of the spectrum on three wave bands as the dials change. A big black dial . . . a big gold dial . . . a big blue dial . . . appear at a touch of the Robot Control.

ROTOR WAVEMAGNET: Electrostatically shielded built-in aerial device for minimizing man-made static and elimination of aerials in many locations. Wavemagnet can be rotated to increase signal strength.

BUILT-IN SHORT WAVE AERIAL: Under proper conditions affords short wave reception without outside aerial or ground connections . . . no special installation needed.

RADIORGAN TONE COLOR BLENDER: Six organ type stops permit 64 distinct and different tonal combinations.

TELEVISION BUTTON: Many television receivers are designed for picture only and the accompanying sound is rebroadcast on a much lower frequency in which case this Zenith receiver may be used to receive the television sound. The highest frequency automatic button may be used by adjusting to the frequency as given in the Zenith receiver instruction book.

MISCELLANEOUS FEATURES: Spinner tuning. Foreign station relocator for accurate logging of short wave stations. Outside aerial and ground connections.

POWER OUTPUT: 15 watts.

★ ★ ★ SPECIFICATIONS ★ ★ ★

CIRCUIT: 12 tube superheterodyne including two heater cathode rectifier tubes.

TUBES:

1—6K7G Tuned R.F. Amplifier	1—6J5G 1st Audio Amplifier
1—6A8G First Detector	2—6J5G Phase Inverters
1—6J5G Oscillator	2—6V6G Beam Power Output Tubes
1—6K7G I.F. Amplifier	
1—6J5G 2nd Detector and AVC	2—6X5G Rectifiers

CABINET DIMENSIONS: Height, 41 in.; Width, 28 in.; Depth, 14⅝ in.

SPEAKER: Mellow, deep toned 10 inch electrodynamic.

CONTROLS: Tuning. Volume and Power Switch. Six-button Radiorgan Tone Color Blender. Band Switch.

CONDENSER: Three gang, rubber floated.

WAVE BANDS: Tuning range of three bands covering:
540- 1600 K.C. (556 -187.5 meters)
1500- 5200 K.C. (200 - 57.5 meters)
5700-18300 K.C. (52.6- 16.4 meters)

AUTOMATIC TUNING: Eight buttons. Separate circuits with extended ranges for each button. Stations can be easily set from front of cabinet.

POWER RATING: 110-125 Volt Line A.C., 50-60 cycles.

PRICE $________

ALWAYS A YEAR AHEAD WITH ZENITH

Figure 4. The 12S568 Console from the 1941 Salesman's Pocket Catalog.

IN USE: THE RCA MODEL 813K (1937)

Chuck Dachis, "The Hallicrafters Collector" waxes poetically about his RCA 816K console. When I found a partially restored 813K (an almost identical radio) at a friend's house for only $200, I resisted less than 10 minutes! The now fully restored 813K resides in my combination office/shack and is generally playing when I'm not DXing. Figure 5 is a snapshot of my 813K.

The 813K's audio is about equal in quality and power to the Zenith's, coming from a four-tube audio section driving a 15" fully enclosed speaker. The selectivity is about the same, as well. The 813K and its big brother, the 816K, offer three things that the Zenith did not:

Band Spread Dials: The four shortwave bands are each spread out over a 10" wide horizontal dial. The dial is marked at each 10 kHz and the marking are each about 3/8" apart. It is very easy to read the dial to about 2 kHz accuracy! The dial tracks very accurately except for the very ends. If you want to tune to 6133 kHz for a Latin "split," you just tune it there. The 813/816K's are the easiest radios to tune of any I have operated prior to digital dials, including the R-4 Drake series. The weakness of the 813K/816K tuning system is that it tunes the four main International Bands *AS THEY EXISTED IN 1937*: 5970-6240, 9410-9690, 11680-11920, 15090-15380. Obviously, the receiver will not tune a few broadcasters who transmit in the widened modern versions of these bands. It also ignores the "new" international bands allocated since 1937.

Green "Magic Eye" Tuning: Most of us have seen the wonderful green "Magic Eyes" of the late 1930's. Zenith offered them only on 1938-40 radios. RCA and a few other manufacturers began offering them earlier. I am not familiar with any postwar American receivers that used a Tuning Eye. I find the Magic Eye to be both fun and a very real aid to tuning to the exact center of a signal. I wish my NRD-525 had one.

Motorized Tuning: Mechanical preset push buttons had not yet been perfected in 1937, so the RCA designers developed an electric motor-driven system of gears and cams which physically moves the tuning capacitor and dial pointer to user-selectable preset position. It is just flat fun to put the radio in Electric Tuning mode, push one of the five preset buttons and watch the tuning knob spin and dial pointer fly across the dial!

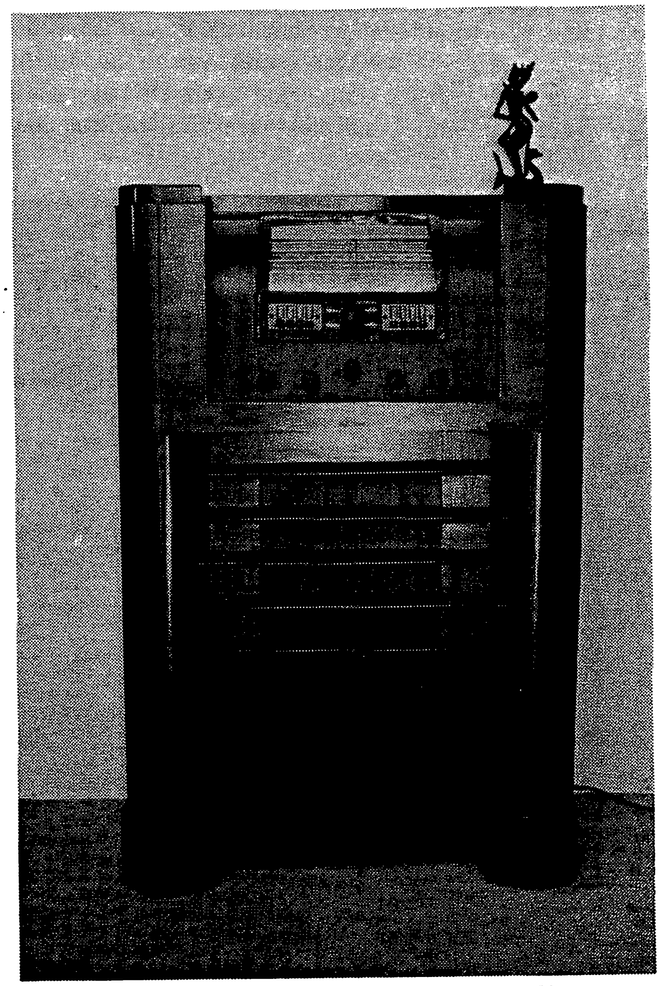


Figure 5. The RCA 813K Console from 1937.

Long-term, I think the Magic Eye, the wonderful dial and the motorized tuning will win out over the beauty of the Big Black Dial Zenith. My daughter and her husband would like to have one of these prewar beauties in their living room, so the Zenith will likely be moving to their home in Baja Oklahoma soon.

FINDING YOUR OWN

If you would like to enjoy a console shortwave radio in your home and know little about them, here are several pointers from my experience and that of Harold Cones:

Age: The very best years for consoles were 1937-42. Anything earlier is not as good technically. Postwar consoles were not really designed for all-wave reception.

Tube count: The quality of a tube radio can be roughly judged by the number of tubes. Five, six and seven-tube consoles were the Bottom-of-the-Line and will probably perform that way. Harold's 10-tube Zenith performs wonderfully. Try for 10 to 15 tubes.

Brand: Zenith was intentionally at the top of the market in each price bracket and produced radios that sold very well in that position. However, the very top models of Philco and RCA perform very well, too. The more nearly custom-built Scotts, McMurdo-Silvers, etc. were wonders, but are now very rare and very expensive.

Price: Within the hobby of vintage radio, Top-of-the-Line consoles are currently selling for $200-$500. The 25-tube Stratosphere is a special case--be prepared to pay from $3,000-$6,000! Prices to the general public at antique stores and vintage radio stores are about double those inside the vintage hobby.

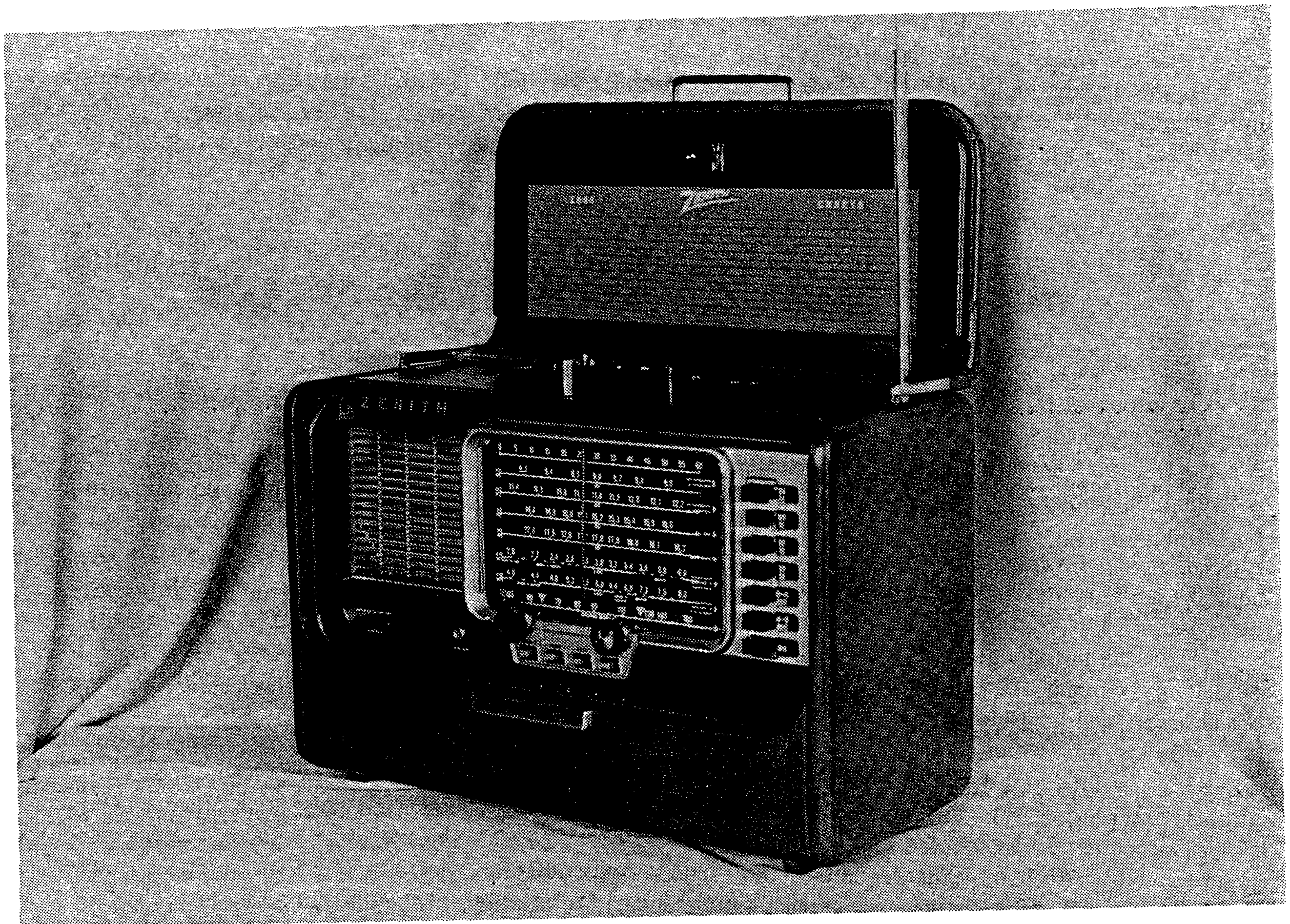
Where: The best place to find consumer type vintage radios is within the vintage radio hobby. There are several national organizations and one national magazine: Antique Radio Classified, (PO Box 2-V78, Carlisle, MA 01741, 508-371-0512, Fax: 508-371-7129.) Subscription to ARC via First Class mail is currently $47.95 per year. Via 2nd Class mail, ARC is $31.95. Sample copies are available FREE! Most states or regions have an active vintage radio club and their activities and contact numbers are listed in the ARC magazine. Most of the local clubs have at least one auction a year. I bought my Zenith at the annual auction of the Mid-America Antique Radio Club in Kansas City. Harold Cones bought his from a collector that he met through the Mid-Atlantic Antique Radio Club.

Size and Weight: Before you commit to buying one of these beauties, be aware that each of them is a large and heavy piece of furniture. Consoles take up a significant amount of space. Further, many of them weigh well in excess of 100 pounds.

Figure 6. This 1937 photo shows Zenith's founding president, Commander Eugene F. McDonald, Jr. at the controls of the 15 tube "chairside" model 15U246. The chairside was a popular cabinet style derived from the more standard console models of the late 30s. *Photo courtesy of Zenith.*

TWO TRANS-OCEANICS

Harold Cones **John Bryant**



Model A600 Zenith Trans-Oceanic

The Zenith Trans-Oceanic is a name still recognized by most of the American public over 40 years of age. That is as it should be. The Trans-Oceanic was a fabled series of portable radios; through much of their existence, they were also the most expensive radios for sale to the general public. They were the single most popular radio marque during the first 50 years of radio. Zenith sold about 1,500,000 Trans-Oceanics during their 40-year long run. Many people now involved in the radio hobbies first heard a shortwave broadcast as teenagers on someone's Trans-Oceanic.

Today, few people know that the Trans-Oceanic was a direct outgrowth of the life style and shortwave broadcast listening interests of the founding president of Zenith, Commander Eugene F. McDonald, Jr.. By the late 1930's, Zenith Radio Corporation was a giant of the new radio industry and Commander McDonald was one of America's wealthiest and best known men. He was a member of the 'jet set' before there were jets and lived aboard his 185' yacht, *Mizpah*, moored most of the year near Zenith headquarters in Chicago. Well known for his Arctic explorations and for his leadership of Zenith, he entertained many world-renowned people aboard the Mizpah and took many of them to his summer fishing camp on the Canadian shore of Lake Superior. As war clouds gathered in the late 1930's, the Commander became more and more interested in hearing news directly from Europe while he was fishing in Canada. Long a shortwave enthusiast, McDonald charged his Zenith design team with creating a portable shortwave radio that he could use anywhere.

At the time of McDonald's directive, portable (medium wave-only) radios based on new low-drain 1.5 volt tubes were themselves a very recent development. The Zenith design team produced a series of prototypes for 'The Commander' based on those new Zenith medium wave portables. After the first few general coverage prototypes, The Commander, complained of needing 'micrometer fingers' to tune in a SWBC station and suggested a multi-band 'bandspread' model that eventually became the first Trans-Oceanic, the 1942 Trans-Oceanic Clipper.

The 'Clipper' was only produced for a few brief months before Zenith shifted to war production. The few thousand produced were wildly popular with the troops and on the Home Front. After the war, Zenith produced tube-type Trans-Oceanics by the hundreds of thousands, eventually offering four main post-War civilian models and one special military version. In late 1957, Zenith offered the first transistorized model Trans-Oceanic, the Royal 1000. Zenith went on to produce three other solid-state models before closing out the marque as they bowed to overseas competition and ceased radio production in the early 1980s.

As the vintage radio hobby developed over the past decade, both tube and solid state Trans-Oceanics became eminently collectable. Many SWBC DXers who have 'collected' a Trans-Oceanic have been surprised with the qualities of the "T-O" as a working shortwave radio. The following two brief reviews highlight what we consider to be the two best-of-breed Trans-Oceanics.

THE '600 SERIES' TUBE MODEL TRANS-OCEANIC

Harold Cones

Sitting down to a listening session with a tube-type (hollow state) Trans-Oceanic is a formidable experience. There before you sits a "Black Stag" covered wooden-cased object 17" wide, 19" high (with the front open) and 8" deep. A 60" telescoping antenna with the base diameter of a hot dog shoots up from the top of the cabinet. In normal usage, with the radio sitting on a standard 29" high table, the whip antenna stops just short of touching the ceiling in a typical eight foot room. Getting the receiver to the table requires hefting 19 pounds (unless you have managed to find a set of Z985 batteries, in which case you brought 25 pounds to the listening site). An impressive radio, for sure, and one that conjures up thoughts of steaming jungles, military battlefields and snowy mountain tops. The Trans-Oceanic was always marketed to adventurers, both real and imagined, and that feeling rubs off on you as you enjoy this radio.

From the introduction of the Trans-Oceanic in 1942 to the end of the hollow state series, there were five main models: the Clipper, the 8G005, the G-500, the H-500 and the 600 Series. Each was an evolutionary step above its predecessor, incorporating improved circuitry and components and some variation in case design.

The last incarnation of the tube-type Trans-Oceanics was the Model 600. Although there were six radios in the 600 Series, each with a different letter and number designation, they all were basically the same receiver. Unlike its airplane dial predecessors, the 600 Series introduced an elongated, horizontally stretched slide rule dial which greatly simplified tuning. When coupled with the electrical bandspread, the 600 Series was one of the easiest consumer radios to tune until the advent of digital readouts in the 1980s. As with other tube-type Trans-Oceanic models, band selections on the Model 600 are made with seven push buttons located to the right of the dial. In addition to the four specific portions of the shortwave broadcast band (16m, 19m, 25m and 31m), there are two continuous coverage bands for "ship-to-shore" and "weather" (2-4 MHz and 4-8 MHz). The 600 Series also introduced a power cord take-up reel and the first dial light in portable radio history. Zenith also reintroduced the attached log book that was last seen on the Model 8G005Y Trans-Oceanic in 1949. The 600 was available in the standard Black Stag covering or, for the first time, a genuine cowhide covering; the cowhide model had brown plastic parts and a brown dial face instead of the black found on the Black Stag models. Many (myself included) feel that the leather covered 600 was the most beautiful of the entire Trans-Oceanic line.

IN USE

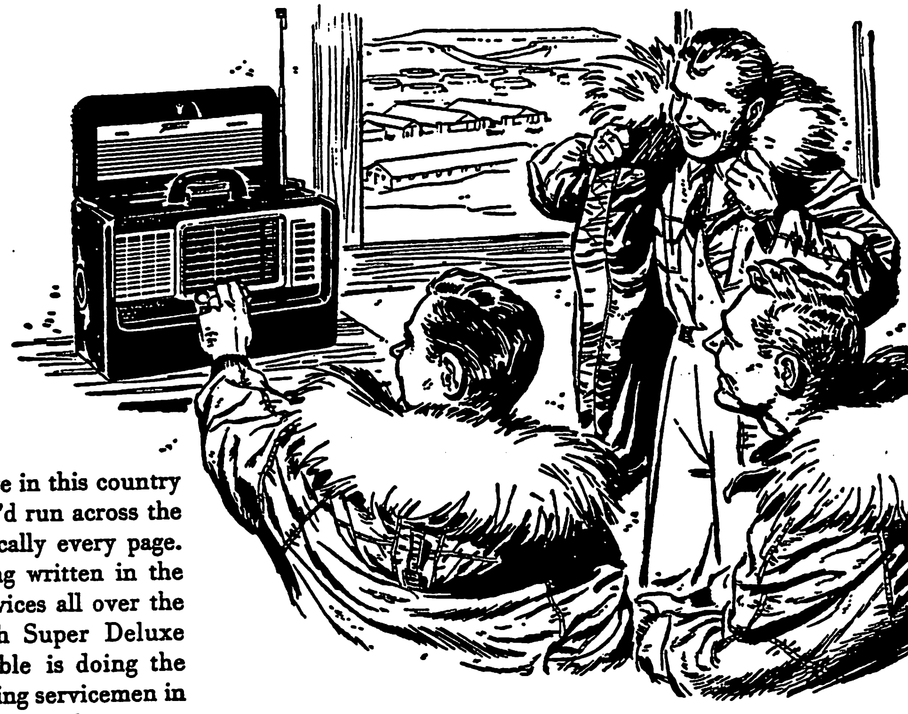
A representative of the 600 Series was chosen for this informal review. A recently cleaned and aligned model A600L ("L" for "leather") was put through its paces with its selectivity and sensitivity loosely compared with an NRD-525.

STABILITY: Hollow state equipment requires a short warmup time before full stability is reached. For this test, I tuned to WWV at 5 MHz., then turned the radio off and let it sit for an hour. I then turned it back on and used sophisticated test instruments (my ears) to listen for tonal changes over time. I could detect none, which affirmed my past listening experience with the Trans-Oceanic—it is a pretty rock-solid receiver.

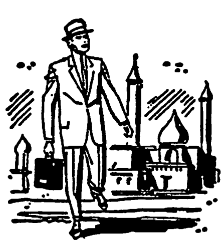
AUDIO QUALITY: In my mucking around with radios, I have never found a portable radio with the audio quality of a Trans-Oceanic. The four switch RADIORGAN allows you to manipulate "Treble," "Bass," "Voice" and "Alto" into as many as sixteen different listening combinations. The result is rich, full audio with enough volume to annoy the whole family if you so wish. An automatic volume control circuit prevents strong station "blasting" in general use. Those who have listened only to recently produced portables are in for a major surprise when they hear a Trans-Oceanic for the first time!

A Brief History of Shortwave

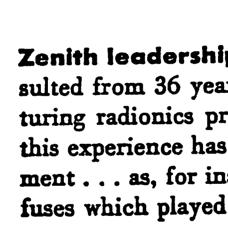
(It's amazing how much of it has been written by Zenith)



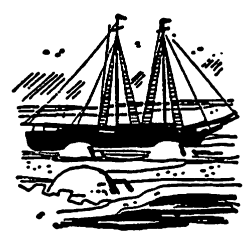
If the history of shortwave in this country were put into a book, you'd run across the name of Zenith on practically every page. The latest chapter is being written in the outposts of the U. S. Services all over the world. There, the Zenith Super Deluxe TRANS-OCEANIC portable is doing the valiant morale job of keeping servicemen in constant touch with home. This is the same...



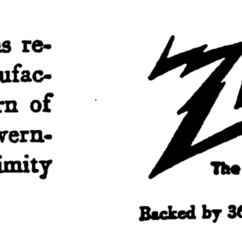
(2) famous Zenith shortwave that has been carried by diplomats, explorers, world celebrities on missions all over the globe. Its list of owners reads like Who's Who. For 13 years it has worked faithfully under very extreme conditions of cold and tropic humidity... on ships, trains and planes. The original...



(3) Zenith TRANS-OCEANIC portable introduced just before World War II, was the realization of Zenith Commander McDonald's insistence on a practical portable that would handle shortwave as easily as standard broadcast. It took Zenith's engineers over two years to develop such a set and...



(4) the production of the now famous Zenith TRANS-OCEANIC portable was begun in 1941. This was only after Commander Donald B. MacMillan, noted Arctic explorer, reported from off the coast of Greenland that never had a radio worked so well under Arctic conditions as the battery operated shortwave set Zenith had supplied him. Even more dramatic...



(5) was the year in the early 20's when Commander McDonald persuaded the Navy, bound for exercises off the coast of Australia, to take along a shortwave transmitter and receiver aboard the battleship "Seattle." When all standard radio failed, this equipment maintained direct contact with the U. S. That was the turning point in the Government's recognition of shortwave.

Zenith leadership in the development of shortwave has resulted from 36 years of devotion to engineering and manufacturing radionics products exclusively. The know how born of this experience has been at the constant service of the Government... as, for instance, in the manufacture of the proximity fuses which played a major role in World War II.

ZENITH

The royalty of RADIO and TELEVISION®

Backed by 36 years of Experience in Radionics Exclusively
ALSO MAKERS OF FINE HEARING AIDS
Zenith Radio Corporation, Chicago 39, Illinois

SELECTIVITY: For this test I tuned in a number of shortwave stations with close adjacent stations and compared selectivity to the standard radios. The Trans-Oceanic was quite capable of rejecting a low powered station 5 kHz away but could not reject a big broadcaster at the same interval. It did surprisingly well at rejection at 10 kHz increments for stations of all powers except the very biggest. All in all, I was quit pleased with selectivity—the Trans-Oceanic is selective enough to make an acceptable DXer's radio.

SENSITIVITY: Although hard to believe, I found that if there is a signal there, the Trans-Oceanic can hear it with either its whip antenna or a long wire attached to its external antenna terminal. Generally, I found that the lower the frequency, the greater the need for an external antenna. Sensitivity was acceptable for general listening in the Tropical Bands, however, the attachment of my tuned dipole to the antenna terminal made the receiver "hot." I certainly never imagined that a 40 year old portable radio could produce such very respectable results!

I tuned a number of Papua New Guinea stations with the NRD-525 and then "found" them with the Trans-Oceanic attached to the external antenna—they were there with equal strength! Most, but not all, could be found with just the whip antenna but were much weaker. The Trans-Oceanic can get them, but in normal shortwave listening situations, the low powered stations would most likely be missed because of the analog tuning (although a calibrated second scale at the top of the dial allows accurate return to a station).

I checked the performance of an "as is" model A600 recently bought at a flea market (I had not yet peaked it up) and found that the same sensitivity was absent. The hollow state circuitry of the tube-type Trans-Oceanic is based on components that can change value over time and can therefore change the performance of the radio from its intended design specifications. Any Trans-Oceanic which will be used for every day listening should be realigned and should have all its capacitors changed to receive maximum benefit from its quality design.

THE BOTTOM LINE: 600 SERIES

The bottom line on the 600 Series Models is that they are very sensitive and selective all band receivers with some of the richest audio you will encounter. They are not only excellent general listening radios (I keep one in my office) but it is also a decent shortwave DXing radio.

Throughout the eight year run of the 600 Series, the retail price of the Black Stag covered versions was $139.95. The versions covered in genuine cowhide cost $159.95. These figures, from 1954 convert to about $800(Black Stag) and $900 (cowhide) in 1994 dollars.

The major problem with the tube-type Trans-Oceanics is that they are no longer made. They are available, however, at ham fests and vintage radio meets and through publications such as Antique Radio Classified.

THE ROYAL 7000 SERIES TRANSISTORIZED TRANS-OCEANIC

John Bryant

There were three models series of transitorized Trans-Oceanics: the Royal 1000 Series, the Royal 3000 Series, and the Royal 7000 Series. The Royal 7000 Series was followed in 1979 by an integrated circuit-based R-7000 Series which closed out the line as the R-7000-2 in 1981. These designations are noted as "Series" because each contained several sub-models produced during their lengthy production runs.

The Royal 7000 Series was introduced in the 1969 Zenith Line as an "11 band portable powered to span the globe and receive more information locally." The "local" comments referred to a new band which tuned VHF weather transmissions. The Royal 7000 model was followed by the Royal 7000Y-1 and then by the Royal D7000Y. The primary difference between the three sub-models was in details of the VHF coveiage. The Royal D7000Y was last offered in the 1979 Zenith line. The retail price at the introduction of the Royal 7000 was $275. At the close of the inflation-ridden '70's, the price had only risen to $300. The introductory $275 converts to nearly $1000 in 1994 dollars.

In modern terms the Royal 7000 is a very large and heavy transistorized portable. Opened for use as in the photo, it measures about 13"W x 12"H x 7"D and weighs in at a whopping 17 pounds with batteries aboard. (In contrast, the Sony ICF-2010 measures aprox. 11"W x 6"H x 2"D and weighs a petite 4.5 lbs. including batteries.) The Royal 7000 measures almost 6 feet from the base of the receiver to the tip of its oversized whip antenna. It is fair to say that the Royal 7000 continued the design theme set a generation earlier when Commander McDonald put performance and audio quality ahead of all other design concerns.

It is important to note that the Royal 7000 also continued the traditional Trans-Oceanic focus on bandspread dials for International Band listening rather than being a general coverage receiver. The 11 bands were the VHF Band, FM, Long Wave, Medium Wave, continuous coverage of 1.7 MHz to 8.0 MHz in two bands, 9.4 to 10.1 (31 meters), 11.4 to 12.3 (25 meters), 14.6 to 15.8 (19 meters), 17.1 to 18.5 (16 meters) and 20.6 to 22.4 (13 meters). Although this approach left large areas of the shortwave spectrum uncovered, it made the Trans-Oceanic one of the few analogue receivers which could be used easily and reliably by the general public wishing to tune international broadcasts.

For the first time in the Trans-Oceanic Line, the Royal 7000 provides switchable selectivity, a variable BFO, and RF GAIN control and a combination Battery Level and Signal Strength Meter. The Royal 7000 also contains an on-board AC power supply and a well designed battery box for nine 1.5 volt 'D' cell batteries.

IN USE

My measures of a "listener's radio' are ease of tuning, frequency stability, audio quality, selectivity and sensitivity, in that order. A listener's radio should be as easy to use as any other piece of consumer electronics and should deliver the major international programs beamed to North America with ease and high reliability. The radios of the Royal 7000 Series do that and more.

EASE OF TUNING: Thanks to Commander McDonald's commitment to bandspread coverage of the major International Bands, Trans-Oceanics (except the final R-7000 general coverage model) are among the easiest analog receivers to tune for international broadcasts. For instance, the 31 meter band is marked off 9.4, 9.5, 9.6, etc. through 10.1. The markings are about 1/2" apart, so it is rather easy to interpolate the dial marker to the nearest 10 to 20 kHz or so. Before running the tests for this article, I aligned my Royal 7000-1 and was able to tune all of the normal powerhouse broadcasters with no problems at all.

STABILITY: The temperature compensation of the Royal 7000 is outstanding. I found no noticeable drift whatsoever during warm-up. The same thing is true for basic oscillator stability. Unlike their replacement, the R-7000, the Royal 7000 series are truly "set and forget" receivers.

AUDIO QUALITY: Almost from the beginning of the company, Zenith enjoyed a reputation for excellent audio quality. The Royal 7000 is no exception. The audio section is rather formidable five transistor circuit with a first audio amplifier, a pre-driver, a driver and an individually matched pair of audio output transistors in push-pull. This circuit drives a high quality 4" x 6" oval speaker which useshas the large case as an unported enclosure. The audio is powerful enough to more than fill my living room with undistorted and quite mellow sound. I informally compared the audio of the Royal 7000 to my Sony ICF-2010. Both in quality and quantity, the Royal 7000 makes the 2010 seem like a plastic toy.

SELECTIVITY: The Royal 7000 was the first Trans-Oceanic to provide switchable (Wide-Narrow) selectivity. The Wide setting is only useful on Medium Wave and the very strongest International Broadcasters. The Narrow setting provides narrower selectivity than previous Trans-Oceanics, but the filter skirts and still wide enough to admit annoying hetrodynes in a few cases. A KIWA 4 kHz. filter would solve those problems; however the problem hetrodynes are so rare that I will probably not bother.

SENSITIVITY: I compared my Royal 7000-1 to the Sony 2010 and the JRC NRD-525 using wire antennas, a McKay-Dymek DA-100 active antenna and the whips of the two portables. On very weak signals, the AGC action of the Royal 7000 was not as effective in holding the audio level even when compared to the other two radios. Fading was more apparent. Medium and strong signal reception was about the same on the three receivers when using the active antenna or the outside wire antenna. The Royal 7000 really "struts its stuff" when operated on its large whip antenna. Well it should; it is the culmination of almost 25 years of design pointed toward creating shortwave radios for consumers who had no desire to string wires up in their back yards. There was no comparison between the Sony 2010 and the Royal 7000-1 when they were operating on whips. The Zenith won hands down.

All in all, the Royal 7000 Series Trans-Oceanics are the receivers to own if you want a transistorized Trans-Oceanic. Unlike the Royal 1000, it tunes the FM band. Unlike the Royal 3000 Series, it offers selectable IF bandwidths and a considerably more sophisticated design. Receivers of the Royal 7000 Series are beautifully designed radios in chrome and black leatherette and is a welcome addition to any room.

FINDING AND BUYING A TRANS-OCEANIC

Within the vintage radio collecting hobby, there is brisk trade in Trans-Oceanics. Probably the easiest way to access this market is by subscribing to Antique Radio Classified (current US rates are $30/yr. 2nd Class and $45/yr. First Class Mail. P.O. Box 2, Carlisle, MA 01741. ph (508) 371-0512.) This monthly publication carries hundreds of classified ads for all sorts of vintage radio gear, a number of informative articles as well as notices of local and regional vintage radio club meets, flea markets, regional auctions, etc. ARC espouses a "no questions asked" return policy for its advertisers. Each issue carries around a dozen ads for various models of Trans-Oceanics. Prices vary quite a bit between various parts of the country; they vary even more based on the quality and condition of the radio in question. Junker "parts sets" go for around $10 to $20. A very well preserved 600 Series Trans-Oceanic varies from about $90 to $150, with the most elegant leather version of the 600 Series usually costing an additional $30 or $40. The Royal 7000 Series receivers are somewhat rarer than the tube models and generally bring from $125 to $175 or so.

"Direct from La Scala...the opening performance of Pagliacci." 25 meter band

"Wave heights expected: 15 to 18 feet off Montauk Point." 162.55 MHz weather band

"The British are 100 for 5 at cricket in Karachi." 19 meter band

"This is North American Service of Radio Moscow with the news." 16 meter band

"Boise: altimeter, two niner seven niner. Ceiling, twenty-five hundred." 150-400 KHz band

"This is ZD8ZAD Ascension Island calling W9DCN Peoria." 13 meter band

"We've taken two marlin here at Pompano...looks good." 1.6-3.5 MHz band

"Next tone begins at 14 hours, 6 minutes, Greenwich Mean Time." 31 meter band

"Hurricane winds of Force 12 expected from 20 hundred hours." 3.5-9 MHz band

"Bulletin: the Coast Guard has sighted survivors." Standard Broadcast band

"And now WEFM presents West Side Story." FM Broadcast band

Presenting the Zenith 11 band Trans-Oceanic. The last word in radio. About $270.*

Built to tune in the world with simplified precision tuning. Electronic band spread tuning widens dial space for easier station selection on five shortwave bands. BFO control for Single Side Band and CW code reception. Tuning meter shows signal peaks for fine tuning. Manual RF gain control to pinpoint RDF locations and facilitate SSB and CW reception.
*Model Royal 7000Y-1, price optional with dealer.

ZENITH
The quality goes in before the name goes on

A FINAL NOTE

Neither of us uses our Trans-Oceanic as a portable radio. We don't want to risk the accidental ding or dent that would forever mar such a thing of beauty. Although batteries are no longer available for the tube model Trans-Oceanics, portability is still possible through a special adaptor battery pack from Antique Electronics in Tempe, Arizona. This pack costs about $90 and runs on owner-supplied D cell batteries. The Royal 7000 and the other transistorized models were designed to run on D cell batteries. Drainage is low and one set of batteries lasts several hundred hours.

FROM THE EDITORS:

Harold Cones and John Bryant currently have a manuscript in the final editing process at Schiffer Publications of Pennsylvania. The 160-plus page book will be very extensively illustrated. Titled *The Zenith Trans-Oceanic: The Royalty of Radios*, it will be the definitive reference on Zenith Trans-Oceanics. Thanks to a lot of cooperation by Zenith Electronics Corporation and by many retired Zenith employees, Harold and John have unearthed much never before available information on these fascinating radios. Look for publication notices in late 1994. The book will be available directly from the authors at *The Radio Professors*, P.O. Box 592, Stillwater, OK 74076 USA.

THE SX-42 AND SX-62

TWO HALLICRAFTERS FAVORITES

John Bryant and James Goodwin

In the closing days of WWII, the major American manufacturers of communications gear faced a very real dilemma. As the War ended, it was obvious that the US government would find itself far over stocked with serious communications gear. This equipment was sure to flood the post-War market at very low prices. The dilemma was especially difficult for Bill Halligan's Hallicrafters Company; this Chicago firm had risen to prominence in the 1930's by offering a full line of low and mid-priced receivers as well as top of the line receivers. If the Hallicrafters philosophy were continued after the War, why should anyone buy a new mid-priced Hallicrafters receiver for $130 when an 8-tube BC-348 was almost universally available at war surplus outlets for $50?

INDUSTRIAL DESIGN AND RAYMOND LOEWY

One of Mr. Halligan's responses to this dilemma was to retain professional consultants to do the "styling" or "industrial design" of the entire Hallicrafters post-War line. Mr. Halligan himself had long been interested in the appearance of his products. He extolled the idea of styling in the late '30s, wanting to" bring the radios in from the garage." In retrospect, it is rather obvious that Hallicrafters receivers, almost from the beginning, were designed with more attention to appearance than were those of competing lines. However, although most consumer radios were being designed by industrial designers in the late pre-War period, it does not appear that Hallicrafters or any other communications gear manufacturer retained an industrial designer in the pre-War period. The distinctly Art Deco look of the Double-Diversity (DD-1) Hallicrafters receiver, the SX-23, the SX-28 and others were all achieved by engineering designers who were obviously influenced by the design trends of the consumer products of the day.[1]

Industrial design had developed in the Depression years as a consulting profession for consumer products. These designers, at first drawn from the ranks of artists and architects, became responsible for applying the principles of visual design, new materials and production processes and the principles of the field that we now cal ergonomics to the external configuration of mass-produced products. In the 1930's industrial designers had been responsible for the streamlined look of everything from locomotives and autos to children's bicycles. They also introduced the European Art Deco style to American products as diverse as silverware, table radios and skyscrapers.

Mr. Halligan retained the industrial design firm headed by Raymond Loewy to design the cabinets and front panels of the entire post-War line, making Hallicrafters the first communications gear manufacturer to retain professional industrial designers.[2] Raymond Loewy was one of the most famous industrial designers of both the pre and post-War periods. After WWII, he operated a national practice with offices in New York, and Chicago. Loewy was responsible for the design of many products for leading American manufacturer including Coca-Cola, Greyhound, Mobil Oil and many others. The Chicago office had been opened to serve long-time Loewy client the Studebaker Car Company. The Chicago Loewy office was eventually responsible for the classic Studebaker lines of the early 1950's and for the Studebaker Avante sport coupe. Fritz Wagner, head of the Loewy Chicago office, was personally responsible for the Hallicrafters account in the early years of their association with Hallicrafters.

THE POST-WAR LINE

Again, in retrospect, it is easy to see that the re-emergence of Hallicrafters radios in 1946 was a very carefully thought out styling, design and public relations blitz. ..The new post-war line initially consisted of one low-priced "entry" receiver (Model S-38), one medium priced receiver (Model S-40), and one top-of-the-line receiver (Model SX-42). Hallicrafters maintained an advertising presence throughout WWII in QST and elsewhere with patriotic ads highlighting Hallicrafters contributions to the war effort. These changed in January 1946 to full-page ads promising a whole new chapter in radio communications and noting that "log books are opening all over the world." In February 1946 double-page ads introduced the Hallicrafters new Model S-40.

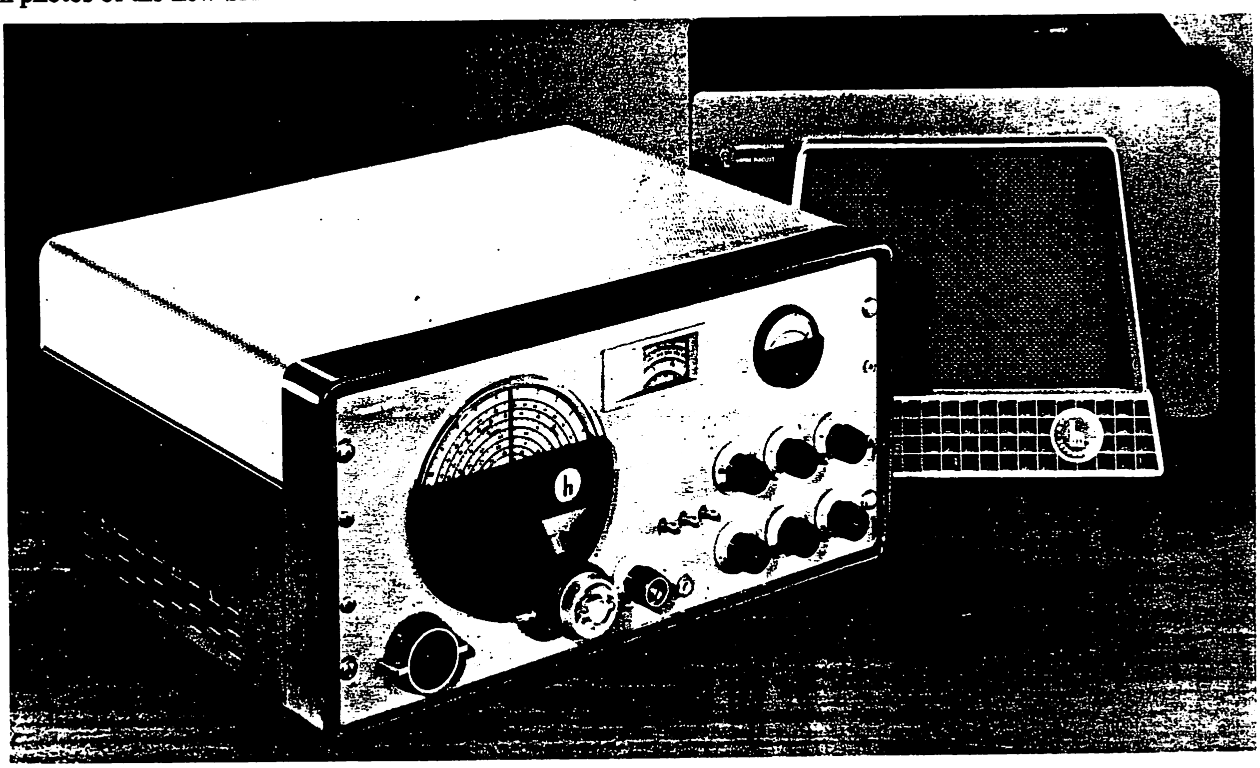
> "New design, new utility in a great new communications receiver...handsomely designed, expertly engineered, Hallicrafters points the way...Look at the sheer beauty of the S-40, listen to the amazing performance...Beneath the sleek exterior of the S-40 is a beautifully engineered chassis..."

The jet black exterior of the S-40, with beautiful glowing green dials was a complete departure on styling from all previous communications gear. It was sleek, businesslike, but distinctly un-military. The massive ad campaign introducing the S-40 continued through May 1946. In June, Hallicrafters introduced the S-38 with an ad campaign equal to the S-40. The S-38 ad also carried a letter from Mr. Halligan in which he stated, "for Hallicrafters, the introduction of the S-38 and S-40 is only a beginning." The ad campaign was repeated in July 1946. In August and September 1946, Hallicrafters continued double page ads, showing both the S-38 and S-40.

INTRODUCTION OF THE SX-42

The Hallicrafters double full page ads in October and November 1946 carried an artist's rendition of the new SX-42 and was headlined "The First 100 Sets Are the Hardest". Ad copy went on to discuss the unprecedented frequency range (.54 to 110 MHz) of the receiver and stated that 'The first 100 sets were now in the hands of radio technicians, engineers and amateurs all over the world' for evaluation. The artist's rendition was quite accurate.

The December 1946 QST magazine was the venue for the introduction of Hallicrafters new top-of-the-line receiver, the SX-42. In an eight-page (!) ad Hallicrafters discussed the features of the SX-42 in loving detail. As if an 8-page presence in a single issue were not enough, virtually all main Hallicrafters dealers each purchased SX-42 ads in that same issue. All of these ads were identical except for size and city name. There were 78 (!) quarter page SX-42 ads, 15 half page ads and 5 full page ads in this December 1946 QST. Fully 40 pages of the 150-page QST issue were covered with photos of the new SX-42! The SX-42 was well and truly introduced!



A UNIQUE RECEIVER

The SX-42 was a truly unique receiver; its attributes probably reflected Mr. Bill Halligan's own view of and interest in radio more closely than any other Hallicrafters radio. The comparative failure of the SX-42 in the marketplace must have been a great disappointment to him.

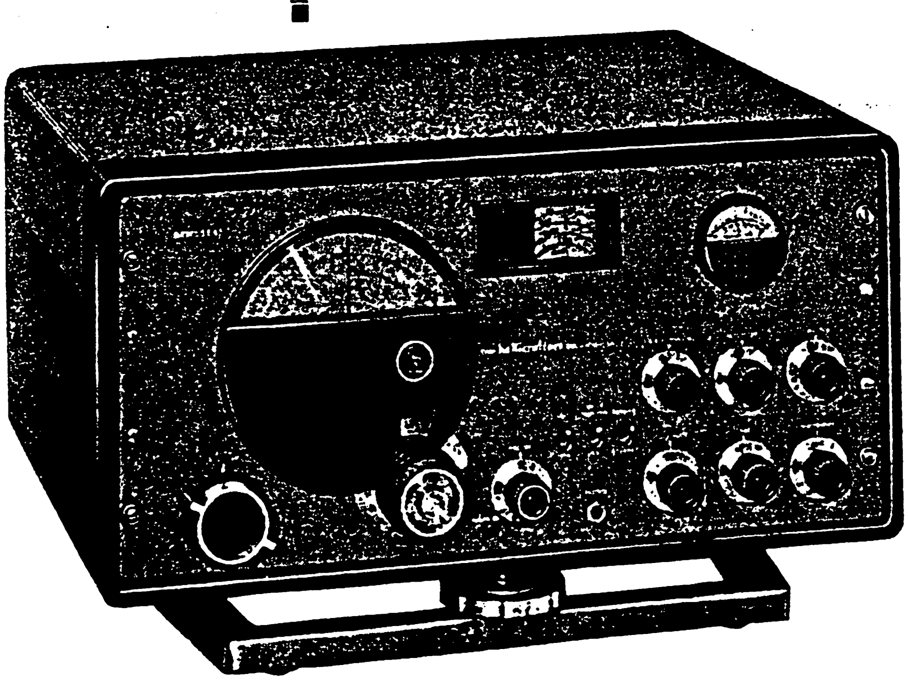
The most remarkable characteristic of the SX-42 is its continuous frequency coverage from .54 to 110 MHz. This coverage may have come about as an attempt to compete with the Hallicrafters SX-28 and other top-of-the-line receivers which would be on the war surplus market. Mr. Halligan and his designers could well have seen an FM-broadcast reception capability as one answer to the problem.

There is reason to believe the idea of the wide-spectrum SX-42 was conceived before 1945, during a period when the radio manufacturing industry regarded FM as the coming force in post-war domestic broadcasting and was even postulating the disappearance of most local AM broadcasting stations.[3] The photograph on the cover of the SX-42 owners manual shows an apparent prototype dial with a logging scale and *four* bands, rather than the *six* of the actual production model. The top band of the prototype appears to cover a range reaching well up beyond 30 MHz but not as far as 100 MHz. This dial layout suggests that the prototype was developed before January 1945 when the Federal *in* **NEW YORK**

MATCHING SPEAKERS

R42 $25.00 — R45 $27.50

Adjustable Base for "Eye-Angle" Tuning — $7.50



Send your name, address and remittance to me, NOW for quickest delivery to almost any part of the world!

73 de

Bil Harrison,
W2AVA

hallicrafters SX-42

$250.00 AMATEUR NET • ADJUSTABLE BASE, MODEL B-42 $7.50

HARRISON HAS IT!

HARRISON RADIO CORPORATION
12 WEST BROADWAY • NEW YORK CITY 7
BARCLAY 7-9854
JAMAICA BRANCH — 172-31 Hillside Ave. — REPUBLIC 9-4102

HAM HEADQUARTERS *Since...* 1925!

Communications Commission ordered FM stations to move from their 42-50 MHz band to 88-108 MHz. If this supposition is true, the Hallicrafters designers would have then been faced either eliminating the FM capability or adding bands and spectrum up to the new much higher FM broadcast band. For whatever reason, the spectrum coverage of the SX-42 and its SX-62 clone was the widest offered by any single commercial set until the introduction of the ICOM R-9000 in the late 1980's!

The second most notable feature of the SX-42 is its tuning scheme. Main Tuning, Bandspread and Dial Lock Knobs are all mounted concentrically on a single shaft. The Dial Lock knob is the inner-most bow-tie shaped knob. When tuning, the operator turns the main dial with the outer knob, locks it and unlocks the inner Bandspread knob with a half turn of the locking knob and completes final tuning with the Bandspread knob and dial. We do not know whether this unique tuning system was developed by Hallicrafters or the Loewy designers. In any case, this knob scheme was not well received by radio amateurs; it was never repeated in any known receiver design.

The third unique characteristic of the SX-42 is the very strong commitment to the shortwave and FM *Listener* throughout the design and documentation of the receiver. The owner's manual begins with a letter from Mr. Halligan which stresses using the SX-42 for "all wave world-wide reception" and noting that the manual is broken into two sections: a non-technical set of instructions and a second section of technical discussions "for the advanced amateur." The attention to the non-hobbyist user is also seen in the color-coding of the non-tuning controls. Red dots on the knobs show the normal settings for AM reception. Green dots show the setting for FM reception. The needs of the all-wave listener were also addressed throughout the circuitry: special wide selectivity settings, "high fidelity" audio circuit design, unusual tone controls (including "bass boost"), and a full 8 watts of audio power developed from 2 6V6 tubes in push-pull. The circuitry provides an essentially flat audio response from 50 to 15,000 cps.

Like most top-of-the-line tube receivers, both the SX-42 and the succeeding SX-62 are enormous by modern standards. The front panels measure 20 inches by 10 inches and the (interchangeable) cabinets are 16.5 inches deep. Each weighs in at a backbreaking, 60 pounds, as well!

The matching R-42 and R-45 (rack mount) speakers were also designed for the audiophile. The 8" speaker (large magnet) is enclosed in a ported "bass reflex" enclosure; a two-position switch on the enclosure offers "Communications" and "High Fidelity" settings. The audio qualities of the SX-42 are excellent, even by today's standards. Listening to classical music on FM with the SX-42 driving either the R-42 or a modern stereo speaker enclosure is a wonderful experience.

CIRCUITRY (SX-42, SX-62)

The receiver covers the range of 550 kHz to 108 MHz in six bands: 550 - 1600 kHz, 1.6 - 5 MHz, 5 - 15 MHz, 15 - 30 MHz, 27 - 55 MHz and 55 - 108 MHz. The circuitry for the first four bands has an intermediate frequency of 455 kHz and provides AM and CW reception. Bands five and six have an i.f. of 10.7 MHz for reception of wide-band AM, CW and FM signals. All i.f. signals pass through three transformer cans, each containing two tuned circuits in parallel, one for each i.f. frequency. The SX-42 is basically the communications receiver type that had evolved before World War II, with the addition of the FM circuit introduced by Edwin H. Armstrong in 1933.

The first SX-42 s that appeared at the end of 1946 had the following 15-tube complement: two 6AG5 r.f. amps., 7F8 converter, 6SK7 1st i.f., 6SG7 2nd i.f., 6H6 low i.f. AM detector/noise limiter, 7H7 1st FM limiter, 7H7 2nd FM limiter/ high i.f. AM detector, 6H6 FM discriminator, 7A4 b.f.o./FM meter amp., 6SL7 a.f. inverter, two 6V6 a.f. output, VR150 voltage regulator, and 5U4G rectifier. In the latter part of 1947, the first 7H7 was made a 3rd i.f. amplifier and the second 7H7 became the single FM limiter and AM detector. After the fiist production run of the SX-62, the Loktal 7H7 s and 7A4 were replaced by their octal counterparts, 6SG7 s and a 6J5. The SX-62/A/B has a 6C4 in the 500 kHz calibrator circuit.

The circuitry underwent no fundamental changes during the almost two decades the SX-42 and SX-62/A/B were on the market. During the first few years a number of successive small improvements were made for the signal path in the final i.f./detector area. The re-design for the SX-62 brought in the 500 kHz calibrator and took out the ganged bandspread capacitors, front-panel crystal phasing control and the combined S-meter/FM tuning meter. The only modification in the audio section over the years was the change of the original output impedances of 500 and 5000 ohms to 3.2, 8 and 500 ohms in the SX-62A.

The components that failed the test of time were the tubular paper capacitors in the early receivers. Any such set surviving today either will have had these replaced or will need to have the work done. Many small economies were effected in the early receivers to help hold the line on costs. One false economy was the failure to provide a fuse in the primary of the power supply. A fuse was included in the design of the SX-62A when capacitor failures in the earlier sets were seen to be causing damage.

Selectivity and sensitivity figures obtained on James Goodwin's SX-42 are:

Selectivity of the three L-C filters at - 6dB: 6, 7 and 13 kHz, with -60dB/-6dB shape factors averaging 3.5. Selectivity of the three crystal filters at -6dB: widths within the range of 50 to 1500 Hz (each filter s width being set by an internal trimmer), and at -60dB, widths of about 7 to 9 kHz.

AM sensitivity with a 6 kHz bandwidth: an average of .75 microvolt over the range of 1.6 to 30 MHz, and 4 microvolt on the broadcast band. With a modern 4 kHz filter inserted, the preceding figures are reduced to about .55 microvolt and 2.7 microvolt. (10 dB signal + noise / noise, 400 Hz tone, 30% modulation)

USING THE SX-42

John Bryant: I never use my restored SX-42 as a serious DX receiver. It lacks pass-band tuning and a notch filter. Further, its narrowest L-C IF filter has very broad filter skirts while the broadest crystal filter is a bit too narrow for my DXing tastes. If my SX-42 were fitted with a couple of KIWA filters and an outboard digital read out, it would be a credible DX receiver, but it would still lack both passband and notch. I use the SX-42 as the program listening receiver in my shack and it is running more than any of my DXing radios. I am lucky enough to have the matching R-42 speaker and really enjoy listening to Afro-Pop or the music of the Andes with the IF wide open and the mode switch in the "high fidelity" position. The audio is wonderful!

When James Goodwin restored my '42, he installed a KIWA 4 kHz filter.[6] Since both the 10.7 MHz and 455 kHz IF signals flow down the same signal path, James took the trouble to make the filter switchable so that I could switch the filter out and listen to FM normally. This also allowed me to evaluate the performance of the SX-42 both stock and modified. In truth, the rather pedestrian stock IF filters of the '42 are adequate for about 75% of my program listening. However, the rest of the time I can really improve the signal/noise ratio, or remove a pesky hetrodyne with the very steep-sided KIWA filter while still getting a fairly wide-spectrum audio.

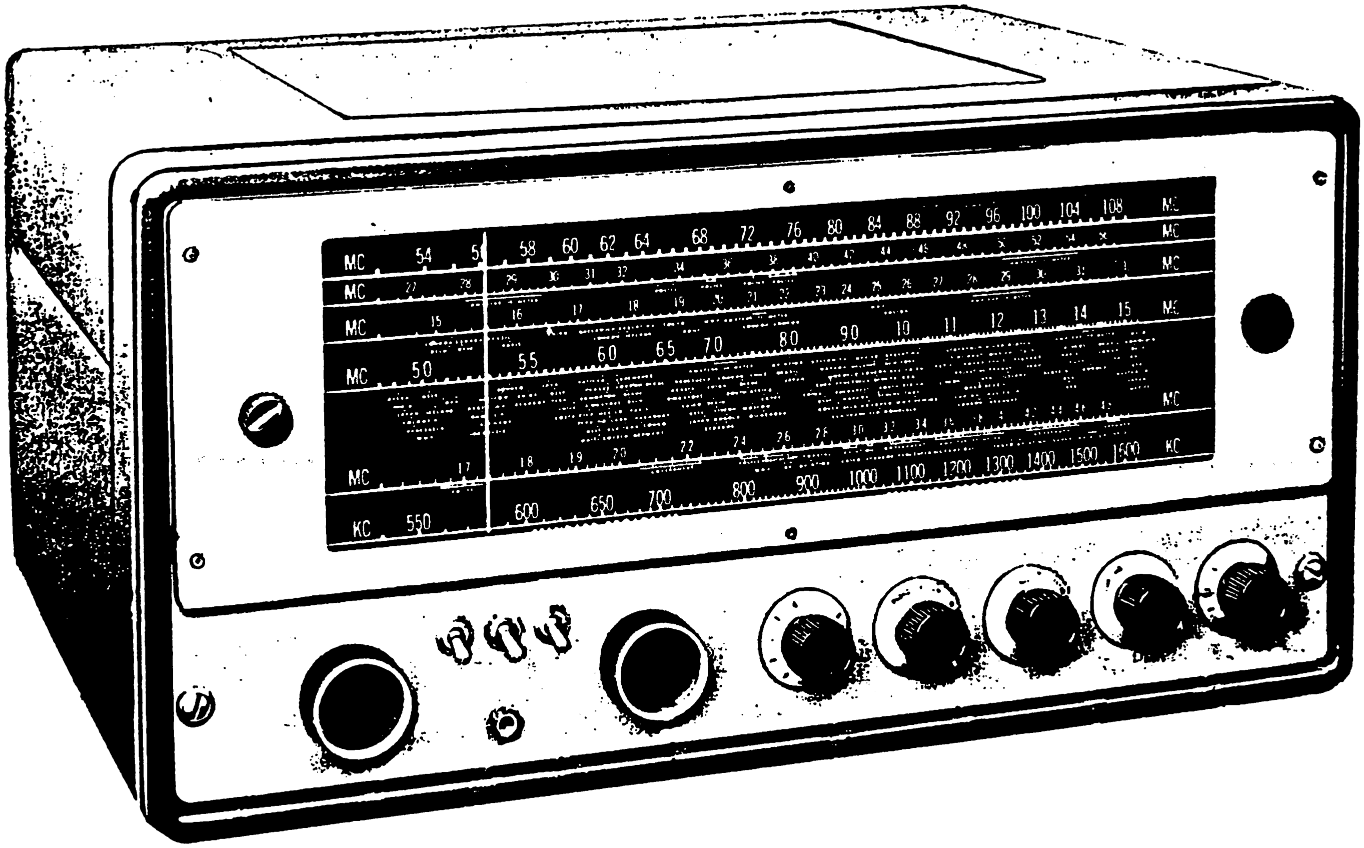
What I like most about the SX-42: I absolutely love the quality of the audio and I like the tuning system. The concentric knobs are both handy and fun to use. The flywheel-backed main tuning knob and brass gearing makes tuning sensual and the design of the index line (actually a 3-D blade) makes it easy to tune the main deal very accurately. I like the looks of the SX-42. It's very nice to have such a beautifully designed radio in the shack.

What I like least about the SX-42: The S-meter is beautiful but just a bit too small for my bifocaled eyes. Also, apparently to reinforce the "clean look" the Loewy designers talked the engineers into placing the 'band-tuned' indications (5-15 MHz, etc.) on the 1/4" wide horizontal EDGE of the band switch knob itself! This is very difficult to read, even in a well lit shack and was a bad design decision.

James Goodwin: I've used my 1946 SX-42 almost daily since I got it third-hand 37 years ago. The i.f. section was up-dated to an SX-62A s 30 years ago, and today it has Kiwa filters with actual bandwidths of 4.5, 3.5 and 2.5 kHz. I've added an outboard digital read-out. The receiver has been run concurrently over the years with a total of 25 other receivers. The 42 is near the back of the pack for oscillator stability, but, with comparable i.f. filters, the sensitivity is about equal to the best tube receivers and is better than that of most solid-state models with broadband front ends. The receiver has one main use. Since I m interested in all s.w. bands and transmission modes, there are a lot of frequencies to check at times like the dawn-enhancement hour. A receiver with good sensitivity and frequency agility is needed. Because the SX-42 has three s.w. bands rather than the five of other good tube models, I can band hop with it more quickly, and with greater freedom of frequency choice than what the memories of a modern receiver can provide.

SIC TRANSIT GLORIA

It is not possible to determine at this point just why the SX-42 was dropped from the Hallicrafters line after only two years. Retail price was probably not the issue. The competing National HRO-5TA-1 and Hammarlund SPC-400 were each selling at $300 each, while the SX-42 was priced at $275 (almost $2000 in 1994 US dollars). Most likely, several factors contributed to the receiver s lack of success with both radio amateurs and all-wave listeners. For the ham, a comparison of the SX-42 with the much less expensive surplus SX-28, showed both had about the same selectivity and sensitivity, but the 28 had features that were downgraded or eliminated in the new receiver. These included elimination of the 28's antenna trimmer, a less capable noise limiter, reduced shielding of the tuning capacitors, a cutback in temperature-compensating capacitors which lead to increased warm-up drift and a number of other more subtle economies. These sacrifices were probably made to maintain a ceiling on receiver price while adding the new FM and alternate i.f. circuitry. For the all-wave listener, the SX-42 was an excellent product, but, it still looked and operated like a traditional ham receiver rather than like a radio for the home. What ever the cause, the SX-42 passed into history with the end of the 1948 model year.



THE SX-62

Like the SX-42, the SX-62 appears to be an outgrowth of Bill Halligan's conviction that there was a significant market for a very expensive "high fidelity" all-wave listener's radio similar to the Scotts and McMurdo-Silvers of the 1930's. Since so much of the circuitry of the SX-42 was devoted to the needs of high fidelity AM and FM reception, deciding to develop a true listeners-only all-wave receiver based on the SX-42 chassis must have been very easy.

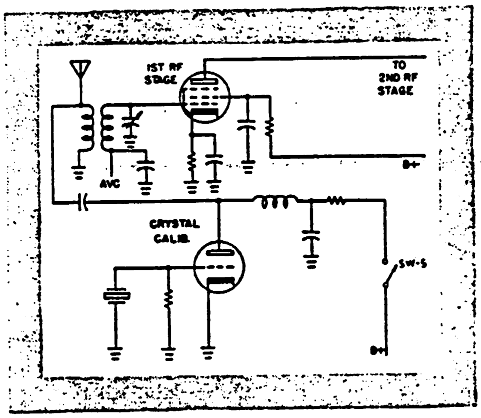
The SX-62 was introduced in 1948 as "the world's finest receiver for the all-wave listener...will outperform any other broadcast receiver on any frequency, standard broadcast, shortwave or FM..." (See ad copy below). The evidence indicates that Halligan and Hallicrafters had finally found the niche market that they had been seeking with the SX-42. The SX-62 was produced in both the US and Canada more or less continuously from 1948 through 1965, the longest run of any Hallicrafters model.[4] The price rose from $269 at introduction to $525 in its final model year. That equates to $1565 and $2340 in 1994 dollars. Throughout most of those years, the SX-62 was the most expensive radio in the Hallicrafters catalog.

Hallicrafters engineers simply removed the band spread capacitor and added a 500 kHz crystal calibrator circuit based on a single 6C4. Otherwise, the tube compliment and general circuity of the first run of SX-62's was identical to that of the now abandoned SX-42.[5]

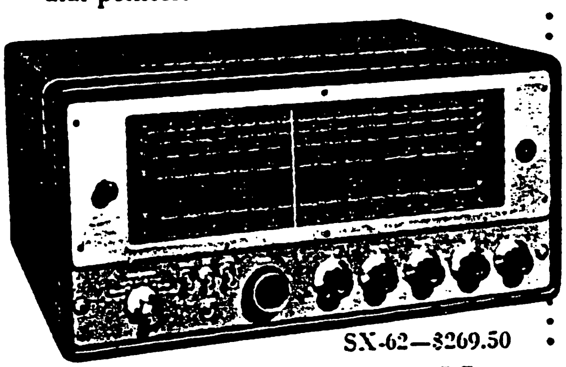
FRONT PANEL DESIGN

The front panel, dial face and dial mechanism designed by Loewy's office for the SX-62 were the largest and most useful all-wave dials ever produced. Like the SX-42, the main tuning knob drove a very heavy flywheel as well as the tuning capacitor, enabling quick frequency changes. The large dial pointer itself could be adjusted plus or minus about 1/2" independent of tuning capacitor position by using the small Pointer Reset knob. With this pointer reset capability and the crystal calibrator, it is easy to maintain the dial so accurately that any international broadcast may be found quite quickly. Beyond the usefulness of the massive slide rule dial, the overall design of the dial, the front panel and the cabinet are such that the SX-62 was and is at home in the Board Room or the Living Room. The SX-62 is a classic of

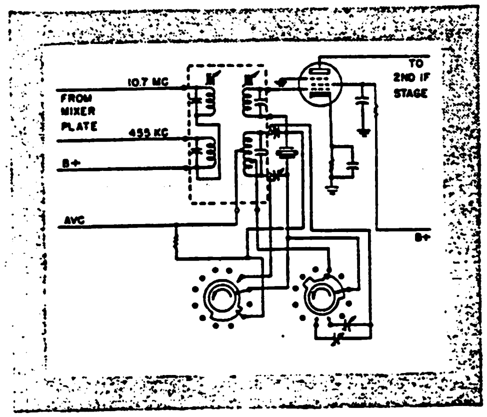
Two Reasons Why The SX-62 Tops Other Broadcast Receivers



CALIBRATION OSCILLATOR for determining exact frequency at any time. A flip of toggle switch SW-5 feeds a 500 kc unmodulated signal into the antenna coil; amplified harmonics appear at 500 kc intervals on all bands up to 32 Mc. Just zero beat the tuning gang with the nearest harmonic and use the "Reset" control to correct the dial pointer.



SX-62—$269.50



SIX POSITION SELECTIVITY control. Here's that extra bit of flexibility no experienced listener would be without. The three sharpest positions use the Xtal bridge circuit above. The other three positions effect necessary changes by varying the coupling in later IF coils not shown. 10.7Mc IF is used on two highest bands.

BEFORE YOU BUY—or let an SWL friend buy—see and try the SX-62. There is no other set in the world like it. None with such frequency range—540 kc to 110 Mc, such ease of tuning—over 150 stations marked on the dial, or such flexibility of control. Truly, a radio that is all radio! Other features include temperature compensated oscillator with voltage regulator, two RF and 3 IF stages, 14 tubes plus rectifier and regulator.

the hallicrafters co.

4401 W. Fifth Ave., Chicago 24, Ill.

MANUFACTURERS OF PRECISION RADIO & TELEVISION EQUIPMENT

1950's understated elegance. The dial itself is over 15" long, spreading the spectrum out over almost 8 feet of dial. The dial is also quite romantic for the radio aficionado, as many of the locations listed on the dial are either spelled archaically (e.g. Djakarta) or no longer exist (Belgian Congo, etc.)

Although the SX-62 has no band spread or incremental tuning, it is quite easy to tune. The mechanical design of the dial is "geared down" so that it requires quite a few turns of the tuning knob to tune across the huge dial. This allows easy fine tuning with the main (only) tuning knob. Movement across the dial is aided by a large flywheel.

IN USE TODAY

John Bryant: Since I spend at least as much time program listening as I do DXing, I find great pleasure in owning what I believe to be the finest all-wave receiver ever built. I have used the SX-62 as my bench receiver for a year or so and have found it very enjoyable. With the proper antenna, I can listen to the local TV broadcasts on channel 2-6 as well as FM, MW and of course SWBC. Although I own an R-42 speaker, I found that one of my old large stereo speaker enclosures matched the high fidelity of the SX-62 very well. The SX-62 sounds wonderful whether on FM classical stations or listening to some of the music aired on HCJB.

Recently, I built a coffee table-height speaker enclosure with the same footprint as the SX-62. The SX-62 now sits atop its speaker enclosure in my office. It has generated numerous conversations about radio, geography and such; I'm also the only guy around our office who can choose to listen to the 5:00 PM news from London, or from National Public Radio or from Channel 4!

The only weakness of the SX-62 that I have noticed is the L-C IF filtering discussed the SX-42. Although I could install a KIWA filter, I have never found that selectivity weakness to be a real problem in program listening. I use my SX-62 almost every day and I enjoy it very much.

SHOULD YOU OWN EITHER ONE?

With the exception of some specialized CW applications, the SX-42 is not really a DX receiver by modern standards. If you want a tube era DX machine to compete with the best of the solid state crowd, an SP-600 or an R-390A aided by a Hammarlund HC-10 is a good bet. So, too, is the still popular Hammarlund HQ-180-A. However, if you would like to own a truly unique piece of major league radio history, or if you would like to use a communications receiver for program listening, an SX-42 may be in your future. Be prepared to look for one. Since they were only produced for two years, SX-42s are fairly rare. Currently they are selling for $200-$500 based on condition.

The SX-62 was never intended as a DX receiver. It remains today just what it was advertised to be in 1948: the finest all-wave receiver ever made. SX-62's are currently fairly common on the vintage receiver market, though they bring similar prices to the rarer SX-42's.

If you have serious interest in either of the magnificent tube radios, you should move quickly. Prices are going up rather rapidly.

AUTHOR'S END NOTES

[1]Interview with Mr. Robert Samuelson as in "The Hallicrafters SX-28" fine tuning's *Proceedings*, 1992-93.

[2]National retained industrial designers to style their 1947 line, the HRO-7, NC-57, NC-173, etc. Hammarlund most probably never retained professional industrial designers.

[3]Empire of the Air by Tom Lewis, Edward Burlingame Books, an imprint of Harper Collins, 1991. A history of radio in the U.S. viewed from the perspectives of the careers of Lee De Forest, David Sarnoff and Edwin Howard Armstrong.

[4]*Communications Receivers* 2nd ed., Moore. Raymond Moore lists production as SX-62 1948-51 (price $269), SX-62A 1955-63 (Price $350), SX-62B 1965 (Price $525)indicates that the tube compliment of all SX-62's was the same as that of the SX-42. This is not correct. The Hallicrafters owner's manual labeled 'SX-62, 2nd Run' lists the more modern tube compliment (elimination of the loctal 7H7's) that Moore shows only with the SX-62A/B.

[5]ibid. Note: Raymond Moore indicates that the tube compliment of all SX-62's was the same as that of the SX-42. This is not correct. The Hallicrafters owner's manual labeled 'SX-62, 2nd Run' lists the more modern tube compliment (elimination of the loctal 7H7's).

[6]"The KIWA I.F. Filter Module" by James Goodwin, fine tuning's *Proceedings* 1992-93 or KIWA Electronics, 912 S. 14th Ave., Yakima, WA, 98902 Phone 1-800-398-1146 or 1-509-453-KIWA.

THE HAMMARLUND SP-600

Phil Bytheway

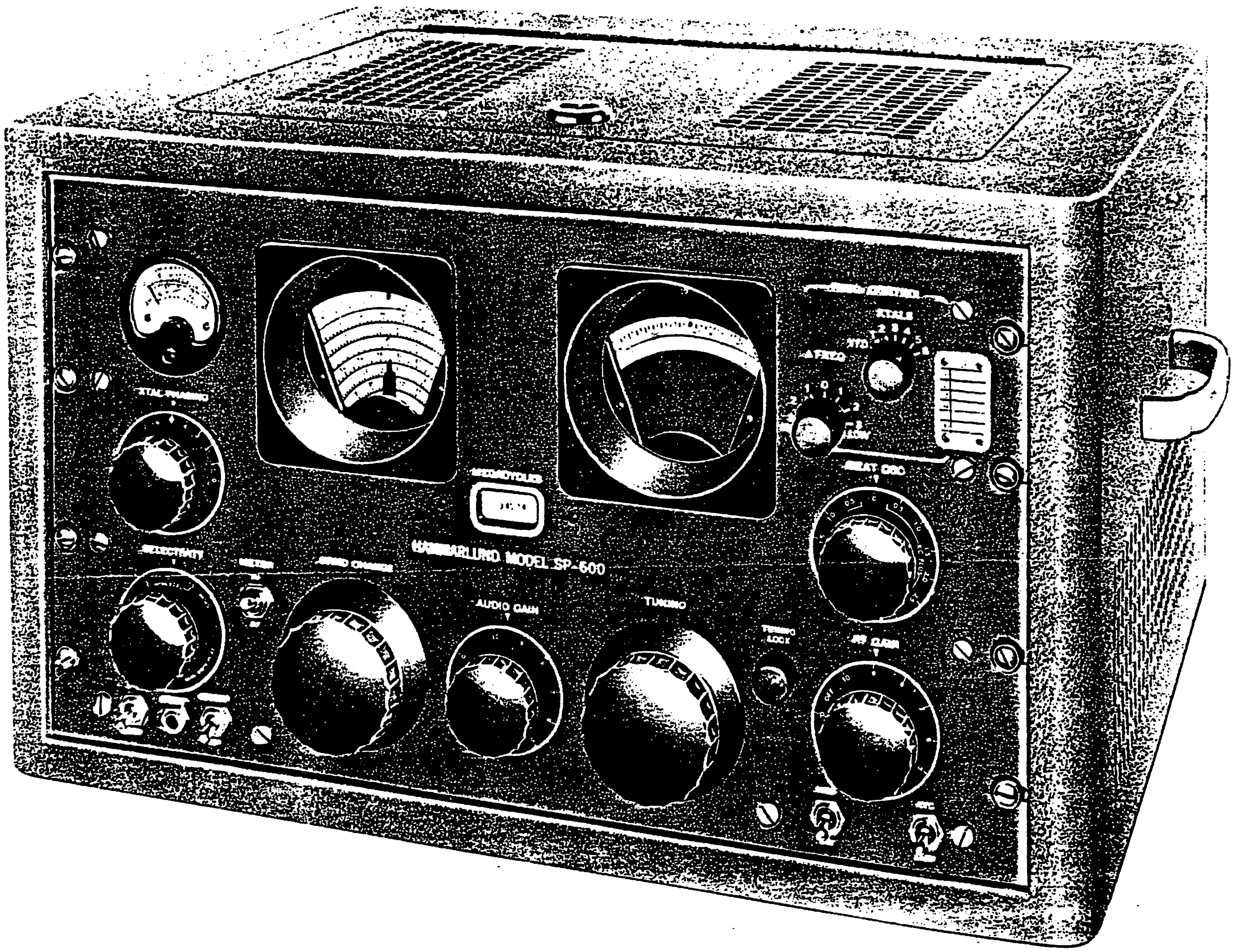


Figure 1: The Hammarlund SP-600-JX

Look at that monster; it must weigh a ton! No, actually the SP-600-JX-xx weighs between 75 and 95 pounds depending on whether or not it comes in a cabinet.

The SP-600 (Figure 1) comes from a long line of snazzy Hammarlund 'Super Pro' receivers, the most notable being the subject of this review. Some models come with a 'J' added to designate a 'militarized' version which used "components having characteristics which are the equivalent of military component specification insofar as practicable"[1]. The 'X' versions can receive 6 fixed channel crystal frequencies in the 0.75 - 54 MHz range. The xx number after the final hyphen indicates the model number within the series which ends with the -26 model. Its design dates from 1950 and variants were built up to the early 1960s. It was advertised for sale in QST as late as 1969. Most were originally sold to the military, government agencies and research laboratories for $1000, but they are now available for a between $50-200 depending on condition.

The SP-600 sports a 20 tube complement, self contained power supply (no solid state!) and can easily be mounted in a 19 inch rack. It is 10 1/2 inches high and 16 1/2 inches deep. The SP-600 was designed for the reception of AM, CW, RTTY and can be used in diversity applications. Coverage is continuous and ranges from 540 kHz up to 54 MHz (6 meters) in 6 bands. The band breaks are at the following frequencies: 1.35, 3.45, 7.40, 14.8 and 29.7 MHz. There is some overlap between the bands. The power supply is designed to operate from AC between 50 and 60 Hz and line voltages between 95 and 270 volts (8 tap settings on main transformer). The marsh mellow toasting factor or typical power draw is 130 watts (1.25 A at 117 volts maximum).

First class construction techniques were used throughout the SP-600-J series. The main tuning capacitor is gold plated and the RF coils for the different bands are contained within a silver turret assembly which rotates the proper coils into position. The VFO drive train is a well made brass gear assembly and the chassis is made from anodized aluminum. To top it off, some sets have all solder connections coated with conformal coating for corrosion protection.

Over the course of my research, I sent questionnaires to 15 SP-600 users, an will quote their responses throughout this review.

FRONT PANEL

Figure 2 shows the front panel of a SP-600-JX-17. Noted SW DXer John Bryant feels that the general appearance of the SP-600...

> *"is one of the most beautiful major receivers made (SX-28 being first, then the SX-88, maybe tied with the SP-600). Unlike the R-390A, the SP-600 is just a pleasure to sit in front of. I also think all of the large knobs are just exactly the right size for hours of use (others have made this exact same comment). Using this receiver shows me, clearly, what we gave up to the miniaturization thrust of 'modern' receivers. Finally, the size and feel of ALL of the controls lets you know that you are dealing with a SERIOUS radio."*

Other survey responses are in agreement with John and no one indicated a desire to relocate any of the knobs.

A tour of the front panel follows. Numbers correspond to those used in Figure 2.

1) The "PHONES" jack delivers 15 mw to an 8000 ohm load if the 600 ohm output (on the back panel) is driving 500 mw to 600 Ω. Audio is very weak with 8 ohm headphones as expected. However it does work well into "auto-level" and "adjustable level" tape recorders. The user can also use the 600 ohm outputs on the rear chassis for audio.

2) This switch is used to select the fixed crystal controlled frequencies and must be set in 'VAR' for normal tuning operation.

3) Selects between internal and external 2nd mixer frequencies (some models). I have not seen this on any of the sets I've viewed and no one mentioned having a set with this switch, so the manual I have is somewhat unique.

4) BFO internal/external, AVC fast/slow control (some models). Once again, I have not seen this on any set but certainly some sort of AVC control is preferred. John Leary mentioned that he built a separate AVC circuit for his set. In the course of normal DXing, situations will arise in which the user needs more than on/off AVC control. On BCB, the 'flutter' associated with so called 'graveyard' (local) channels demands a much slower AVC than on the regional or clear channels.

5) Turns the BFO on/off. Definitely a preferred feature. So often the 'modern' radio designers have decided when to enable the BFO, often excluding certain bandwidth selections unless in SSB. You can use the SP-600s BFO with all selectivity selections.

6) Puts the set in standby, thus disabling the RF amplifiers via screen voltage. B+ is applied at all times.

7) RF gain also contains the AC on/off switch.

8) Tuning knob. This is connected to a flywheel counter balance which allows for very easy tuning (and high speed spinning!). John Bryant notes: "the aesthetic thrill of giving the tuning knob a spin is WONDERFUL! The gear train and the big flywheel seem perfectly matched to move quickly and accurately across the bands. Clearly, the best main tuning knob in the business." Anti-backlash gear tensioners are used in all interfaces and there is no discernible backlash when tuning. The ratio for tuning to main dial is 50:1.

9) This large knob is used to change bands. Like all boat anchors, it is difficult to turn and a good grip with high torque is required. Keep in mind that 4 sets of coils are being manipulated when changing bands (a la HRO!).

Note: the tuning/band knob arrangement of the Super Pro series differs from the 'traditional' Hammarlund/Collins arrangement of leftmost knob for tuning, rightmost knob for band changing/band spread. For someone moving between an HQ-180/R-390A and the SP-600, a bit of reorientation is necessary. Do NOT try standing on your head. Those of us who are left handed (a minority to which I belong) are further hampered by having to cross the front of the receiver to tune the set. I still love the ease of tuning however; it really flies!

10) This allows +/- 3 kHz variation of the tuning frequency when in the fixed crystal mode... nice to have front panel fine tuning when using a crystal.

11) Readout in 10 kHz to 1.35 MHz, 20 kHz to 3.45, 50 kHz to 7.40, 100 kHz to 29.7 and 200 kHz to 54 MHz. In addition, at the top, a 0 to 5 log scale is provided for use with the vernier dial (explained later).

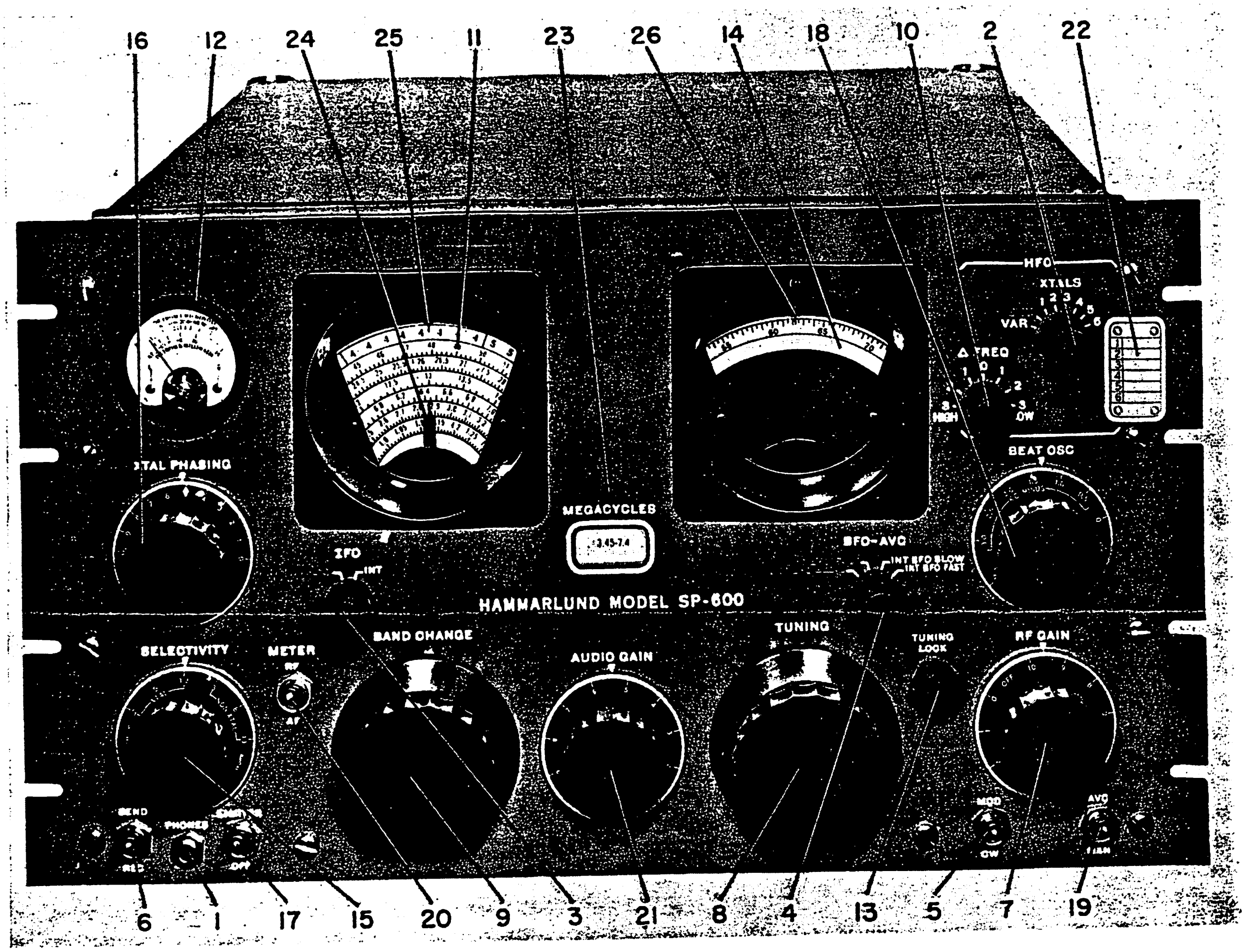


Figure 2: SP-600-JX-17 Front Panel

12) S-meter, 0-200 μA, calibrated directly in kHz with respect to 455 kHz. This one also shows AF strength, although most folks don't use this feature. More users rated the S-meter performance as 'ok', a couple indicated 'accurate' and only one called it 'poor'. There are adjustments on the rear chassis for this so perhaps a wide range of opinions are possible. On my set, I noted that there was less than full deflection when tuning in locals and slight deflection when tuning in weak signals, much more dynamic than a lot of signal strength meters I've used. I prefer a meter that doesn't pin easily, which allows me a visual means of 'peaking/tweaking' antennas and tuners. If the S-meter pins easily, one can still use the slightly detuned BFO audio technique for peaking external devices.

13) Locks the internal tuning mechanism, although the tuning knob still rotates.

14) The Vernier dial is a full 0-100 with markings every 0.5. This dial, combined with the log scale at the top of (11) can be used to return to a known frequency within 1 kHz, you just have to write the log value down!

15) Bandwidth, 13.0, 8.0 and 3.0 kHz bandwidths are available without the crystal filter. The crystal filter is switched in for bandwidths of 1.3, 0.5 and 0.2 kHz. Most folks use either the 1.3 or 3.0 kHz position for DXing and the 3.0 or 8.0 position for casual listening. Close DX situations almost always require the 1.3 kHz filter.

16) This control is used when in the 1.3, 0.5 or 0.2 positions to adjust the phasing of the single pole crystal filter. The single notch can be moved through the passband. I can't find any documentation on the notch depth. The manual describes it as 'extreme selectivity for the high attenuation of closely adjacent interfering signals.'[1] Most users rate the usefulness of this feature as "excellent" to "good".

17) The noise limiter tends to mess up the audio, because it is designed for to reduce noise from ignition systems and other pulse noise sources.

18) The BFO frequency control is very handy. It is calibrated to +/- 3 kHz in 0.5 kHz increments that are at least 1/4 inch apart. When combined with 'normal' band station separation (10 kHz BCB, 5 kHz SW), it can be used to determine the frequency of off channel stations within 0.1 kHz. Of course a frequency counter/readout would be a better solution, but for a strictly analog readout, this setup is most impressive.

19) Enables/disables the AVC. It's a shame this set doesn't have an adjustable AVC timing. It would help out quite a bit in some BCB flutter frequency situations.

20) This allows the user to switch between RF and AF readings on the 'S-meter'. AF is generally only used for adjusting low-level audio into a telephone cable. These receivers were often installed in remote receiver sites. Audio outputs went to a control station through telephone circuits in which levels needed to be closely controlled. For use with a speaker at the same site as the receiver, the AF meter option really isn't needed.

21) Controls the volume into the headphones and rear 600 ohm outputs.

22) A good idea to keep track of the crystal values plugged into the crystal rack, just in case you forget such things.

23) It's also a good idea to know what band the set is tuned to, even though the pointer (24) moves up (and down) as the band is changed.

25) Combined with the pointer in the Vernier window (26), station 'log' values are tabulated.

So much for the front of the set. The antenna connection is located 'inside' the set mounted on top of the RF chassis (mine is BNC). On the back there is a power connection, a couple of fuses and a spare fuse box (usually missing!). You will also find an array of screws for the diode output, AVC and audio output connections. A four line 'remote' female connector allows access to various internal signals. A PL-259 connector is available for the IF output (not specified, but measured 3.5 V peak-to-peak). Rear mounted screw adjustable potentiometers allow for BFO and 'S-meter' adjustments for both the RF and AF modes. On the -17 versions, two additional PL-259 connections provide inputs for externally supplied 2nd VFO and BFO signals.

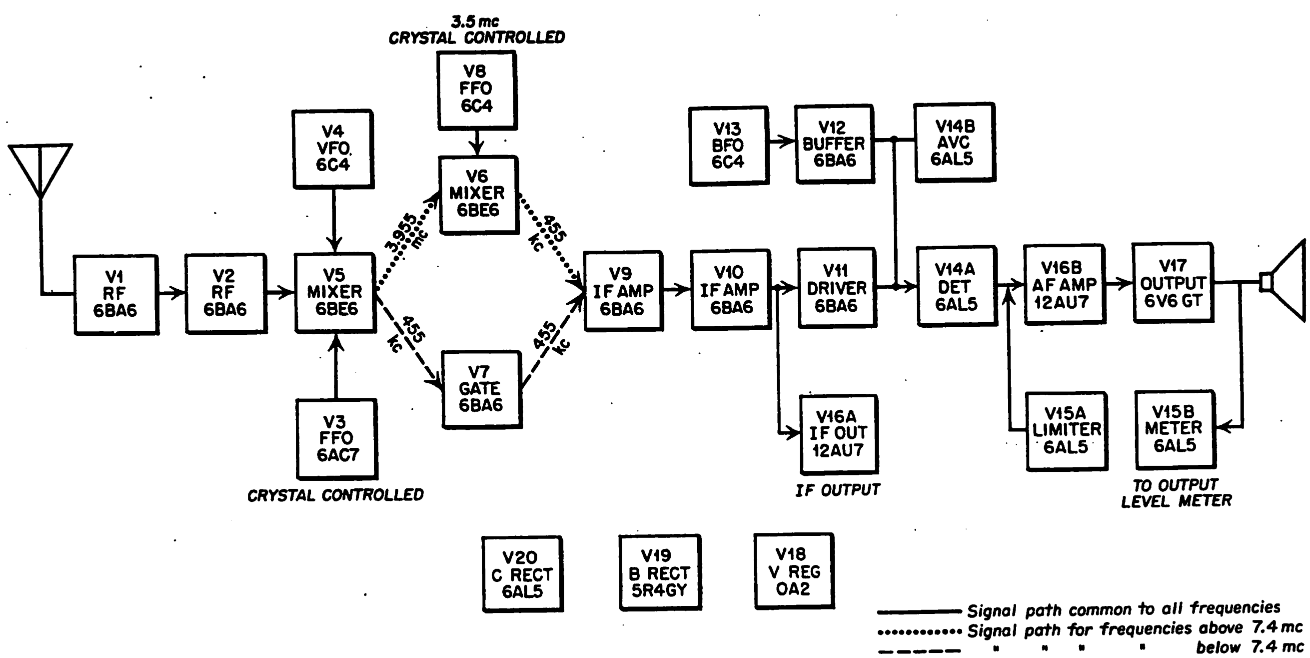


Figure 3: SP-600-JX-17 Block Diagram

CIRCUIT DESCRIPTION

Figure 3 shows a simple block diagram. Four band dependent tuned circuits are switched in for the 95 ohm balanced antenna input (before first RF), first and second RF (both 6BA6) and first VFO (HFO-6AC7) circuits. In the fixed crystal controlled mode, the crystal controlled oscillator is connected in place of the first VFO (thus implying that the fixed crystal frequency is not the same as the desired frequency). Depending on band selection, the first mixer (6BE6) produces a 455 kHz signal for bands 1-3 - below 7.4 MHz, or 3955 kHz signal for bands 4-6 - above 7.4 MHz. The second VFO (6C4) generates a crystal controlled 3.5 MHz signal for the 2nd mixer (6BE6). On some sets, this second VFO is selectable from the front panel to an input on the rear chassis. This all means the set is single conversion below 7.4 MHz and double conversion above, with 455 kHz as the final IF frequency.

The 455 kHz signal via the gate (6BA6 - below band 4) or 455 kHz output of the 2nd mixer (band 4 and above) is selected for injection into 2 IF stages (both 6BA6). The selectivity switch adjusts all 3 IF coils (before 1st IF, between 1st and 2nd IF and following 2nd IF) with the first (before the 1st IF) being the location of the crystal filter and phase adjustment. The output of the 2nd IF is buffered (12AU7) to a connector on the rear chassis. This output can be used with a matching panadaptor for viewing post filtered IF behavior. The RF gain potentiometer controls grid voltages of the 2 RF and to a lesser extent the 2 IF tubes. Following the driver (6BA6), the audio is extracted with a diode detector (6AL5). The BFO circuit (6V4 LC controlled oscillator followed by 6BA6 buffer) is coupled at the driver. Once again, in some receivers, the BFO is selectable to a rear chassis connector via a front panel switch (which also adjusts AVC attack speed). The AVC is buffered (6AL5) and drives the gain of the 2nd mixer/gate and both IF amplifiers, as well as the S-meter (when in the RF mode).

The output of the detector is clipped by the noise limiter (6AL5 - when enabled) and fed into the Audio gain controlled AF amp (12AU7) and presented to the single, class A output driver (6V6) which drives the 600 ohm (at 2 watts) and headphone outputs and the S-meter (when in the AF mode). The B+ is regulated to 150 volts (OA2).

THE THREE S'S AND MORE

SENSITIVITY. The SP-600 manual rates sensitivity at 2.3 uV or better over the entire tuning range for a signal to noise ratio of 10 db at 20 mW output with RF at maximum (1 µV for CW). For John Bryant,

"The intelligibility of weak signals is EXCELLENT. It was far better than my NRD-525 in many careful comparisons. When using the 525 and MAP combination to compare to the SP-600, the SP-600 was almost always better or tied with 'the best solid state can do'. The SP-600 is very sensitive and then the tube audio quality really improves intelligibility."

Bill Kleronomos says

"Comparing it head to head with the R-390A, HQ-180, SPR-4 and R-70, using similar antenna, I did not find any situations in which the SP-600 was unable to receive a signal the others had. Sensitivity was measured using a 30% modulated carrier to check the 10db S+N/N rating of this receiver. For those of you not familiar with this test, it takes into account the thermal and other noise produced within the receiver and provides a figure of merit used by the electronics industry. Merely hearing a signal is not good enough if it is masked by a high internal noise level! The sensitivity was checked at 1, 4, 14 and 50 MHz and measured 0.6, 0.6, 0.7 and 1.5 µV, respectively. This is not bad for AM sensitivity. CW signals were readable at 0.1 uV or less throughout the range. Overall, this receiver has very good sensitivity with somewhat high thermal background noise."[2]

SELECTIVITY. (Figure 4) Selectivity is variable: 13, 8 and 3 kHz bandwidths are available without the crystal filter. With the crystal filter, bandwidths are 1.3, 0.5 and 0.2 kHz. The filter's phasing knob allows for the frequency adjustment of the single notch. When properly adjusted, the single pole crystal filter provides very, very good single signal CW reception using the narrow bandwidths.

For domestic BCB DX, the SP-600 performs well. I typically use the 3 kHz position, as the 1.3 kHz was too narrow for my tastes. Foreign splits are readable in the 3 kHz bandwidth. What with domestic broadcasters squeezing every kHz out of their bandwidth, a loop antenna is almost mandatory for adjacent channel reception, even with the best of selectivity enhancements. I sometimes used the 1.3 kHz position to DX. However, in my SP-600, there appears to be quite a bit of loss associated with the crystal filter... perhaps mine is not perfectly aligned.

John Bryant adds

"For use on shortwave, either listening on the International Bands or DXing on the Tropical Bands, the selectivity of the SP-600 - stock - is not up to modern standards and almost makes this otherwise wonderful receiver unusable. The L-C IF filters are not well suited for AM reception on the modern densely packed International Bands. The 13 kHz filter was always too wide for anything except local powerhouse MW reception. The 8 kHz filter can be used to a degree on the International Bands, but the shape factor is so bad that all sorts of 'trash' comes in under the skirts of the filter. There is also a continual 5 kHz whine from adjacent channel signals even when tuned to the strongest International signals. The 3 kHz filter also has such wide skirts that the continual weak 5 kHz hetrodyne is present. The 6 dB width of this filter is, however, too narrow for really good audio when SWLing. For casual listening, a low pass audio filter would clear up the hetrodyne, but rob you of the higher audio frequencies. The 3 kHz filter is marginally useful as a DX setting, however, the terribly wide filter skirts still let in a lot of trash. The 1.3 kHz crystal filter is a good DX setting for the Tropical Bands, but very careful tuning is required. I have no experience DXing with the narrower crystal settings.

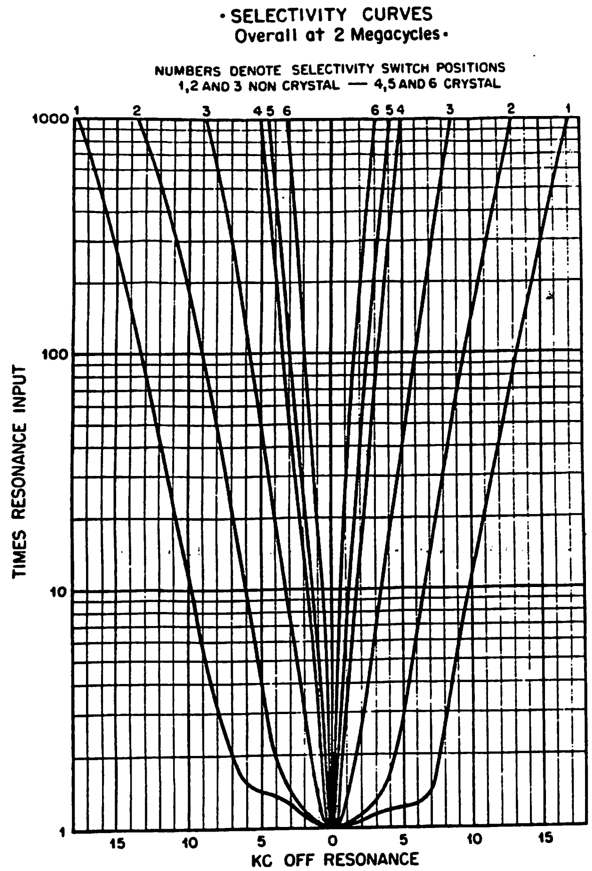


Figure 4: SP-600 Selectivity Option Curves

"My experience leads me to strongly recommend some modification of the IF situation if this otherwise wonderful receiver is to reach its full potential as both a DX and listening receiver on shortwave.

"One approach to this problem is adding one or two more modern IF filters to the set... possibly the new add-on filters from KIWA Electronics which are reviewed in Proceedings 1992. I have not done this, but James Godwin has. Refer to his article in Proceedings 1992.

"Currently, I am using a Hammarlund HC-10 unit in conjunction with the SP-600 (a 2700 ohm or so dropping resistor is best for this interface). This unit receives a 455 kHz signal from the output port on the rear panel of the SP-600 and then processes it through what is, essentially, the IF and AF sections of an HQ-180A. It provides a tunable IF notch filter, passband tuning, selectable sideband AM and SSB reception and sports excellent IF filters (at 60 kHz). The HC-10 and SP-600 combination provides excellent selectivity and a nice wide (6 kHz) setting with steep filter skirts, perfect for shortwave listening."

STABILITY. Per the manual, frequency drift after a 15 minute warm up period ranges from 0.001-0.01%. I can't really argue as I've never noticed any stability problems. Bill Kleronomos notes

> *"A series of stability tests were conducted after a 1 hour warm-up. Due to the thermal inertia exhibited by the massive silver-plated cast front end assembly, I observed that stability continued to improve until thermal equilibrium was reached. This took about six hours! For the most critical applications, I recommend leaving this receiver on all the time in standby mode. I also noted that stability was greatly improved by using the 130 volt tap in my area (versus the 117 volt tap typically used) where the nominal line voltage is 123 volts. After warm up, I measured the stability over a 10 minute period. This receiver held to within 30 Hz at 14 MHz and 10 Hz at 7 MHz. The BFO drifted less than 1 Hz over the same period. In crystal control at 10 MHz, drift was less than 2 Hz over 12 hours. Mechanical stability was checked at 14 MHz. Shaking the operating desk produced no change. Frequency only jumped a few Hz when a sharp blow was applied to the cabinet."*[2]

IMAGES: There is a weak birdie on 910 kHz, and the normal expected mixing spurs from locals are evident across the BCB. Using a loop antenna only alleviates the problem if you null the offending dominant station. The preselection provided by the loop's tuning doesn't seem to help. The two RF stages are perhaps more a problem than a blessing in the SP-600 (many signals get into the first mixer). Image and Spurious responses are rated at better than 74 db. Bill Kleronomos again "These were checked at 40MHz and were unmeasurable due to test equipment limitations, which means 90 db or better; an outstanding figure."[2]

AUDIO DISTORTION: Measured distortion at 1kHz ranged from 3% at 100mw, 6% at 500 mw and 10% at 1 w. Audio response was basically flat from 100 Hz up to the selectivity limit.[2] The only audio distortion I noted was when the Noise Limiter was switched on. Although the limiter works very well on noise, it also distorts the audio, often making signals difficult to understand.

PRACTICAL USE AND STUFF

ANTENNAS: John Bryant has used 90 meter full wave deltas, an array of 450' Beverages and an amplified ferrite bar loop (for MW). All are impedance matched to 50 ohms. All seem to work well with the SP-600's antenna input (95 ohm) on Tropical Bands. John does not own an antenna tuner, however, with impedances already closely matched, he feels that a tuner would not improve matching. On the other hand, my experiences with various MW loops (4-5) has been somewhat different. I was unable to get my 'Wedge' loop to perform well with the SP-600. The Wedge has a single ended FET input amplifier with a 50 ohm emitter-follower output stage. The Space Magnet loop (with a similar, but different emitter-follower output stage) was the best of the bunch, as it appeared to have little or no loss. There is no antenna trimmer on the SP-600. Those surveyed indicated a preference for one and most users indicated that they used an external tuner. It is a clear necessity if interfacing with a wide variety of antennas.

TUNING: I've found tuning on the BCB to be very nice with this set. Naturally, the BCB has the largest distance between stations... I can imagine the serious SW DXer having problems in crowded bands where the space between 5 kHz stations is a breath away. Using the variable BFO, it is fairly easy to nail BCB stations within a kHz; even eye-balling to 0.1 kHz when appropriate, although I really don't have much experience using the SP-660 to hear 'off frequency' foreign stations. Since the BCB is broken into two pieces (breaks at 1350 kHz), the flywheel action is a MUST for bandscanning. The entire BCB readout is to 10kHz, including the portion on band 2 from 1350 to 1600. Above 1600, marking moves up to every 20 kHz as noted above.

John Bryant adds

"From an aesthetic point of view, I love the SP-600 tuning. However, from a practical point of view, it leaves much to be desired. The commitment to a single tuning rate, rather than main and band spread, forced the designers to compromise on gear ratios; this is one receiver that really needs a stick-shift transmission. The counterweighted flywheels do make moving from one part of the dial to a distant point a fairly easy and rapid task. However, for fine tuning or slowly sweeping across one of the Tropical Bands, the gear ratio is wrong... you truly need the touch of a safe cracker. I find that I always need to throw on the BFO to make sure that I am exactly tuned to the signal. I do wish that there were either gear-driven or electrical incremental tuning. On the other hand, tuning the SP-600 is FUN... you are aware of controlling a real radio and you are aware that it takes practice and skill to get the most out of this beauty. It is sort of the feeling that F-16 pilots must have... it ain't easy, but is sure the heck is fun.

"I have only used the logging scale a few times just to see if it would work. It works like a charm. The receiver is stable enough that I can return to the same signal days later very easily and very predictably. If I was not lazy, I would have developed the frequency charts necessary to be able to read frequencies to the kilohertz. Instead, I have installed the digital frequency readout by CCI which is reviewed in Proceedings 1992. I feel very guilty about this, I should be a purist and use charts. I have both a 200 Hz and a 1 MHz crystal calibrator on board my SP-600. Using those to judge how much the dial is 'off' in a particular area, I can read the main dial to +/- 5 kHz. Not bad. It is also rather easy to see that the dial itself is not quite linear with the radio. It is quite close, however."

SPEAKER: I never got a speaker for the set because it has a 600 ohm output. The scarcity of 600 ohm speakers is one of the drawbacks to buying any surplus receiver. I have used the SP-600 as a Trans-Pacific parallel checking set; it gets the stronger NHK stations easily enough when using a 150' longwire. I switch it into my 'audio system' consisting of a multiple selection switch feeding the input of a reel-to-reel tape recorder always kept in the 'record' mode. Volume adjustments are easily made with the audio gain knob on the SP-600 or the record level knob on the tape recorder.

COMPARISONS

David Clark rates the SP-600 better than an HQ-180 on BCB, but gives the edge to the HQ-180 on Tropical Bands, and generally prefers the SP-600 over an R-390A. Jef Jaisun notes that it outperforms a GE Superadio II and Sony ICF-SW7600 on MW. Bill Kleronomos prefers his SP-600 for casual listening and fast tuning, something impossible to do with his R-390A. Hank Holbrook prefers the HQ-129X which is far superior for crystal tuning. Shawn Merrigan prefers the tuning of the SP-600 when bandscanning and against the R-390A and NRD-525 it compared favorably, though harder to find a specific station.

MODIFICATIONS - ELECTRICAL PROBLEMS

BLACK TUBULAR CAPACITOR: This is documented over and over; they simply must all be replaced. These black tubular capacitors (39 - 0.01µF, 14 - 0.02 µF) are famous for developing leaks and shorts thus clobbering the performance of this set. And a potential fire hazard as well! They should be replaced with 1 kV disc ceramics. Unfortunately, a number of space problems will arise when doing so, as the circuitry is often crammed. People used to doing this kind of work usually spend about 100 hours at it! It is an exercise in dexterity and perseverance and should not be attempted by any but the most experienced people. An excellent technique is to make small drawings of the circuitry BEFORE removing the tubulars, then, with the help of the schematic few errors are made. It's also a good idea to test your replacement capacitors BEFORE installing them. Interesting descriptions of the task can be found in *Hollow State Newsletter* #19, p 7-8, #20, p 2.[3] Thanks to Bob Kulow for pointing this out to SP-600 owners... and yes, all users surveyed had either replaced their capacitors or had problems with 'blown' ones (and have their fingers crossed!).

FILTER CHOKE LEAKAGE: Remove all wires from both filter power supply filter chokes and measure the resistance to ground. Many are less than 15 ohms indicating poor internal isolation from ground. It's best to insulate the chokes from ground by enlarging the base plate mounting holes, and then remount the chokes using insulated step washers. Don't forget to remeasure the resistance after mounting to be sure they are completely isolated. Hollow State Newsletter #18, p 4.[3]

SELECTIVITY ENHANCEMENT: Dallas Lankford describes a technique for adding Collins mechanical filters within the filter preceding the first IF in the Hollow State Newsletter #15, p 4-7.[3]

Three excellent and interesting articles by Bill Kleronomos in Electric Radio #20, 21 and 22 describe several additional receiver 'tweaks' and modifications. These include: frequency drift due to poor B+ and filament voltage regulation (vastly improved SSB and CW reception), construction of a high performance product detector (everyone needs a product detector... although quite a bit of reworking the set is required), and tube exchanges to improve performance. The third of these is worth mentioning further because it is the most useful. It's also the easiest to do.

Tube substitution of the RF amplifiers with tubes of lower noise figures greatly improves the overall noise figure of the SP-600. Replace the RF 6BA6s with a 6DC6, 6DK6, 6GM6, 6JK6 or 6GU5. The list of tubes is in descending order of equivalent noise resistance; even the 6DC6 change is a vast improvement.

OVERALL OPINION

John Bryant:

"My SP-600 is a completely remanufactured unit which was stripped to parts and then reassembled using as many new components (including tube sockets, all caps and resistors, etc.). It also has a new audio section (design similar to the Collins 75A4) and a new SSB module and two crystal calibrators. It's RF and IF sections for AM are stock, however. For all purposes, it is an electrically brand new unit with better audio. I am using an HC-10 unit with my SP-600.

"With the SP-600/HC-10 combination, I have found the main receiver that I will use for fixed base DXing and for program listening for as long as I continue in radio. I have spent many hours comparing the SP-600/HC-10 with my highly modified NRD-525 and MAP combination. In almost every DX situation, the SP-600/HC-10 either wins or ties the NRD combo. Besides being as sensitive, more or less, and as selective, more or less, the vastly superior audio quality of the SP-600/HC-10 is extremely useful when trying to understand audio that is at the noise floor.

"What this system CAN NOT offer, however, is the convenience and nimbleness that the memories and other fruits of automation bring to the major solid state receivers of the late 1980s. Personally, I think that I will continue to use something like the 525 to FIND the DX and the SP-600/HC-10 to HEAR and UNDERSTAND it."

Having used many receivers over the years, I can truly say I enjoyed the many hours spent in front of my SP-600. As John has pointed out, it is a wonder to tune. I originally purchased my SP-600 shortly after I was married in 1976 and it was set up for DX in the 'spare room' of our house until my son was born in 1980 (thus terminating the designation 'spare room'). I did have some problems interfacing my loops with the set, and you all know that loops are a BCB DXers best friend! So I drifted away from the set in favor of a R-392, which had a built in antenna tuner; and better readout too. The SP-600 was soon sold in favor of a smaller, more compact set which fit my slightly revised DX style. In preparation for this article I obtained another set and used it head-to-head with the other radios in the shack, including two solid state sets. I was once again impressed with the performance of the SP-600; it's definitely a 'keeper'... I'm glad it's back!

I would like to thank the many SP-600 owners/users that assisted me with this article including: John Bryant, David Clark, James Goodwin, Hank Holbrook, Jef Jaisun, Bill Kleronomos, Dallas Lankford, John Leary, Pat Martin, Shawn Merrigan, Rick Setliff and Jack Woods.

I would also like to thank the organizers and editors of Proceedings for giving me this opportunity to 'hit the big time' by generating this review. They have been more than patient with all my various delays, still finding it within to encourage me to keep working. Thank you folks...

REFERENCES

[1] *GENERAL PURPOSE COMMUNICATIONS RECEIVER MODEL SP-600-JX AND MODEL SP-600-J INSTRUCTIONS*, published by The Hammarlund Mfg. Co, 460 W 34th St., New York NY (out of print I would suspect)

[2] Bill Kleronomos KD0HG, 'Hammarlund Super-Pro: SP-600JX-17' and 'Update That Super-Pro' (series), *Electric Radio*, issues ??, 20, 21 and 22; P.O. Box 57, Hesperus, CO 81326.

[3] *Hollow State Newsletter* reprints are available from *HSN*, PO Box 1831, Perris CA 92572.

from 10 KCS **The widest frequency range parameter in the industry** to 54 MCS

HAMMARLUND

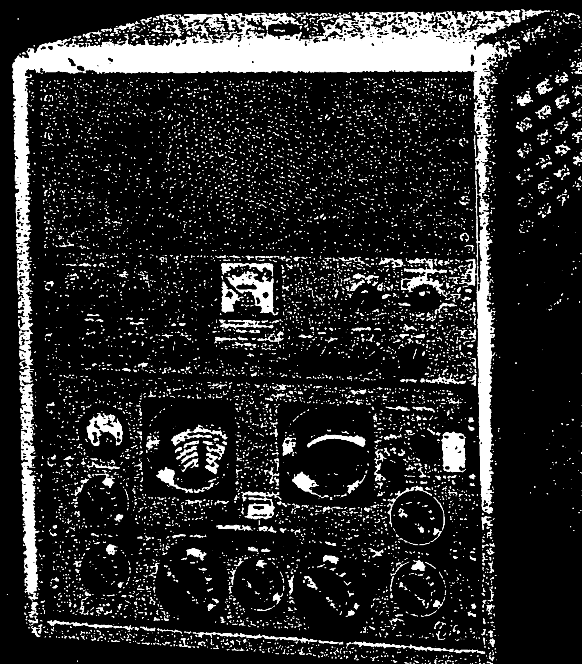
SSB RECEIVING EQUIPMENT

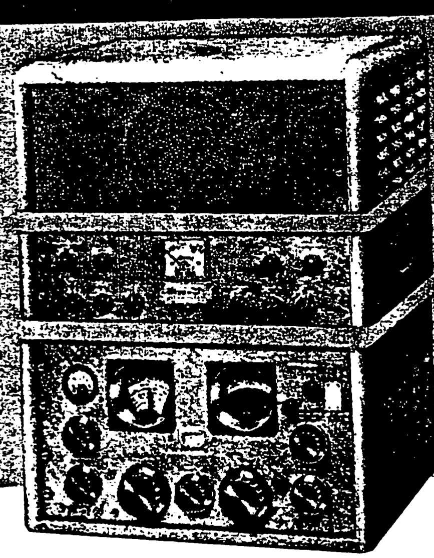
SP-600 Receivers/SPC-10 SSB Converter

For Commercial/ Military applications

The Hammarlund Manufacturing Company now offers a complete line of commercial/ military communications receiving equipment incorporating unexcelled performance and value for all communication modes from 10 KCS to 54.0 MCS. This modern Hammarlund equipment is designed in modular, or package form to enable the user to buy what he needs to meet his specific requirements, whether it is a brand-new installation, or the addition of more sophisticated performance, including SSB, to present equipment.

Hammarlund maintains a complete communications equipment engineering facility that is ready to serve you in any communications problem. The Hammarlund reputation for quality, plus the Hammarlund history for value, adds up to your guarantee for the best buy possible . . .





SPEAKER
The Hammarlund SP-300 Speaker is rack-mounted, incorporating a high response 8" P.M. 600 ohm speaker assembly.

CONVERTER
Hammarlund SPC-10 SSB converter that may be used with any standard communications receiver having an IF frequency of 450 KCS to 500 KCS. Also adds new selectivity quality to AM/MCW reception.

RECEIVER
The world-famous Hammarlund SP-600 Series. Available in three frequency ranges for single or diversity (model SP-600-JX17) reception in cabinet or rack-mounted units.

CABINETS
Hammarlund supplies cabinets for any combination of the above three units as enclosures for the standard relay-rack mounting units. Cabinets are completely louvered for ventilation.

1. Normal independent operation wherein the receiver is operated in conventional fashion.
2. Master Operation wherein one high frequency crystal oscillator within one receiver supplies output for the purpose of controlling the frequency of another receiver as well as controlling itself.
3. Slave Operation wherein the receiver is controlled by another receiver operating as a Master.
4. External Operation wherein the receiver obtains its high frequency local oscillator injection from an external source common to two receivers.

POINT-TO-POINT RECEPTION—With its six crystal-controlled fixed-frequencies, the SP-600 is the perfect receiver for point-to-point and network applications. Operators of these receivers can pre-arrange day and night fixed-frequencies to provide the best reception possible. By using crystal control, the operator can select a channel immediately without searching.

Whether you want to operate on a fixed-frequency for contact with an individual station or network, or roam the entire receiver range from 540 KC to 54 MC in search of other contacts, you can't operate a finer receiver than the SP-600-JX.

SPECIFICATIONS

SPECIAL DIVERSITY MODEL
SP-600-JX-17
Same as SP-600-JX except provisions for master or slave operations, i.e., internal or external H.F. oscillator, B.F.O., and adjustable A.V.C.

Standard Model Frequency Range, SP-600-JX
6 Bands ....0.54 to 54.00 mc
Band 1 ....0.54 to 1.35 mc
Band 2 ....1.35 to 3.45 mc
Band 3 ....3.45 to 7.40 mc
Band 4 ....7.40 to 14.80 mc
Band 5 ....14.80 to 29.70 mc
Band 6 ....29.70 to 54.00 mc

Special Low-Frequency Models SP-600-JL and SP-600-JLX
Band 1 ....100 to 200 kc
Band 2 ....200 to 400 kc
Band 3 ....1.35 to 3.45 mc
Band 4 ....3.45 to 7.45 mc
Band 5 ....7.45 to 14.8 mc
Band 6 ....14.8 to 29.7 mc

Very Low Frequency Receiver Model SP-600-VLF
Note: All specifications same as SP-600, except the following:

Frequency Range:
Band 1 ....10 to 16 kcs
Band 2 ....16 to 26 kcs
Band 3 ....28 to 50 kcs
Band 4 ....50 to 100 kcs
Band 5 ....100 to 217 kcs
Band 6 ....217 to 540 kcs

Fixed Frequency Reception: Four crystal-controlled positions for any frequency within range of receiver.

Maximum Undistorted Audio Output Approximately 2.0 watts.

Output Impedance 600 ohms. Balanced split windings.
Phone jack-winding: delivers 15 milliwatts to an 8000 ohm resistive load, when the audio output to the 600 ohm power load is adjusted to 500 milliwatts.

AVC Action Maintains the output constant within 12 db when the input is increased 80 db.

Variable Selectivity Three crystal filter and three non-crystal filter positions provide 6 db bandwidths from 200 cycles to 13 kc.

Sensitivity 0.75 to 1.0 mv on CW and 1.50 to 2.3 mv on AM for a signal to noise ratio of 10 db.

Antenna Input Optimum coupling from a 100 ohm transmission line. Balanced doublet or single wire antenna may be used.

Double Conversion Double conversion is employed on frequencies between 7.4 mc and 54.0 mc.

Image Rejection Ratios Better than 72 db throughout the frequency range.

Beat Frequency Oscillator Variable from zero beat to 3 kc.

Tube Complement
Total—20
RF, IF and BFO Amplifiers ....7—6BA6
HF, 2nd Conversion and BFO Oscillators ....3—6C4
Crystal Controlled HF Oscillator ....1—6AC7
Mixers ....2—6BE6
Detector, "C" Bias Rectifier and Noise Limiter and Meter Rectifier ....3—6AL5
AF Amplifier and IF Output ....1—12AU7
Power Output ....1—6V6GT
Rectifier ....1—5R4GY
Voltage Regulator ....1—OA2

Vernier Log Scale 600 vernier divisions for each frequency band readable to one-tenth division making 6000 readable divisions per band.

Power Supply Requirements
Line Rating ....95, 105, 117, 130, 190, 210, 234, and 260 volt taps, 50-60 cycles.
(A-25 60 cycle model is also available.)
Power Consumption ....130 watts, 1.25 amps. at 117 volts.

Tuning Meter Calibrated in db from 1 microvolt on AVC and in db from 6 milliwatts audio output.

Front Panel Equipment
Main Tuning—Vernier (combined)
Dial Lock
Band Selector Switch
Band Indicator Window
RF Gain (with On-Off switch)
AF Gain
Selectivity
BFO Pitch
Crystal Phasing
Send-Receive Switch
AVC—Manual Switch
CW—Modulation Switch
Limiter On-Off Switch
Tuning Meter
Phone Jack
Meter-Switch

Rear Panel Equipment
BFO Injection
Convenience Outlet
Balanced Antenna Input
AVC—Detector Diode Output
Balanced AF Amplifier Outlet
IF Output
AF Meter Adjustment
RF Meter Adjustment

Crystal Control For operation of the "JX" and "JLX" models on fixed frequencies above 750 Kc, any one of six channels or VFO is selected by a front panel selector-switch. Additional facilities on these models include:
Crystal Frequency Vernier   Channel Chart

Dimensions Size of the cabinet model is 21½" wide, 12¾" high and 17¼" deep. Weight 87½ lbs. The rack model is 19" wide, 10½" high and 16½" deep from rack mounting surface. Weight: 66 lbs.

Specifications subject to change without notice.

APD639

SP-600 SERIES RECEIVERS

No communications receiver has ever established a record for performance and dependability such as that of the Hammarlund SP-600. It is used throughout the world for military, commercial, and amateur users. It compares with receivers costing far more, and now, through the addition of the Hammarlund SPC-10, offers operational features exceeding virtually all other receivers at any price.

The SP-600 communications receiver is a 20-tube dual conversion superheterodyne, available in three frequency models ranging from 10 KCS to 54.0 MCS. Receiver frequency ranges are listed under **Specifications.** It contains its own power supply. Operation of any one of six crystal controlled fixed frequency channels within the range of the receiver is immediately available, while variable tuning of the receiver range is accomplished over six continuous bands. Stability is excellent, ranging from .01% or better at 540 KCS to less than .001% at 54 MCS. Image rejection is 74 db down, and spurious responses are at least 100 db down. Sensitivity is a maximum of 1 microvolt CW and 2 microvolts AM. Selectivity for the three crystal and non-crystal filter positions is from 200 cycles at the narrowest bandwidth to 13 KCS at the broadest bandwidth. Radiation is negligible with no cross-talk in multi-receiver installations.

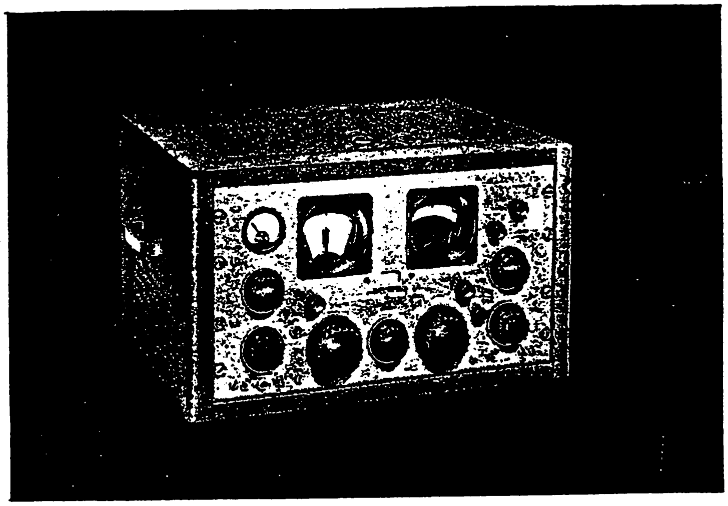
MECHANICAL DESCRIPTION—This 20-tube radio communications receiver is supplied in either a well-ventilated steel cabinet finished in dark gray to complement the lighter gray front panel, or for mounting in a standard 19" relay rack. Power input requirement is 130 watts. The standard power supply has taps to permit operation from various power sources, 90 to 260 volts and 50/60 cycles. A 25-60 cycle power supply model is also available.

The standard model covers a frequency range of 540 KC to 54 MC divided into six bands operated by a band selector switch on the front panel. A special low frequency model with a range of 100 to 400 KC and 1:35 to 29.7 MC is also available.

The single tuning control is massive and of special design to permit maximum traverse speed as well as operating ease. It controls both the main and vernier dials. An anti-backlash gear-train provides extremely close calibration accuracy (0.25% or better) and accurate resetability.

The ratio of the vernier dial to the main dial is 6 : 1 and the tuning control to the main dial is 50 : 1. Approximately six complete revolutions are made by the vernier dial while the main dial makes its complete band coverage. An arbitrary outer scale on the main dial indicates the revolutions made on the vernier scale in each particular band. The vernier scale provides 100 major divisions with half division markers for individual station logging. Because it is easy to estimate 1/10 divisions on the vernier scale, this system makes it possible to divide each frequency band into approximately 6000 readable settings.

A tuning lock provides for positive locking action without affecting the frequency setting. A band indicator window on the front panel shows the frequency range of the band in use, and at the same time, a dial frequency indicator is aligned with the proper dial scale.



ELECTRICAL DESCRIPTION—A two scale tuning meter is used on AVC operation. Normally this meter indicates the accuracy of tuning and the relative strength of received signals in db from one microvolt. Depression of the front panel meter switch converts the meter circuit to indicate output level in db from 6 milliwatts.

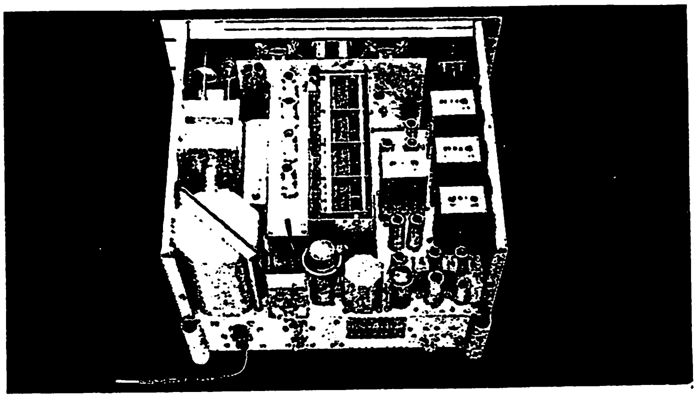
The RF gain control is provided for manual control of sensitivity to prevent over-loading by strong signals when operating with the AVC-Manual switch in the Manual position. This control also operates when the switch is in the AVC position.

The Send-Receive switch desensitizes the receiver but leaves the power on to provide for instant reception between transmission periods.

The circuit for single conversion, used for signal frequencies up to 7.4 MC, consists of 2 stages of RF amplification, first-mixer, first heterodyne oscillator, four stages of IF amplification, detector and AF amplifier and output power stage. The power supply system includes power rectifier, bias rectifier and voltage regulator. The circuit for double conversion, used for frequencies between 7.4 MC and 54.0 MC, employs a 2nd mixer and crystal controlled 2nd heterodyne oscillator in addition to the stages used for single conversion.

Due to double conversion circuits, images are practically nonexistent in the receiver. Image rejection varies between 74 db and 120 db, depending on the band.

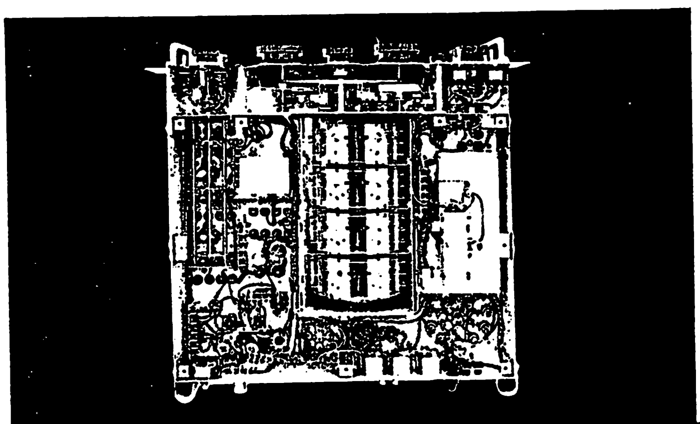
An ingeniously designed rotary turret is employed to change bands and to place the coil assemblies of the RF amplifier, mixer and first heterodyne oscillator stages directly adjacent to their respective sections of the four-gang tuning capacitor and their respective tubes. This assures maximum sensitivity at high signal to noise ratio.



The AVC circuit is provided with separate time constants for CW and MCW operation and the tubes employed are used as a high level detector and AVC rectifier.

The beat frequency oscillator employs a high capacity Colpitts circuit which gives excellent frequency stability and minimizes oscillator harmonics. It is connected into the detector through a buffer amplifier which eliminates oscillator lock-in and permits variation of the beat oscillator injection by means of a control located on the rear of the chassis. A front panel control varies the audible beat frequency from zero beat to plus or minus 3 KC.

The noise limiter circuit limits the interference from electrical equipment or other sources of pulse type noise, such as ignition noise. A control switch permits optional use of the limiter on any mode of operation when pulse type interference is present.



A resistance coupled triode amplifies the audio frequency signal received from the detector. The audio output tube is transformer coupled through a split balanced winding to deliver 2.0 watts of undistorted output to a 600 ohm load. A separate secondary winding provides attenuated audio signal output for headphone operation. Radiation is negligible and complies with requirements for shipboard operation and for multi-receiver installations.

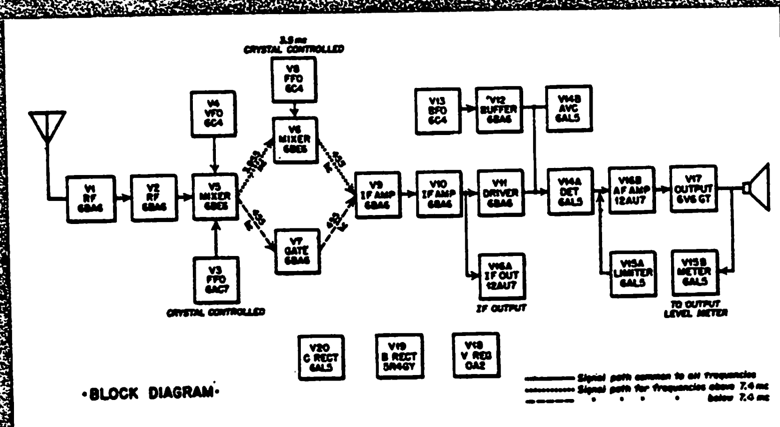
Frequency drift after a 15 minute warmup varies between .01 per cent at the lower frequencies to .001 per cent at the highest frequencies. This is a frequency stability previously unattainable in any but crystal controlled circuits.

Remarkably uniform sensitivity over the entire frequency range is maintained between 0.7 and 1.0 microvolt in telegraph communications and from 1.2 to 2.0 microvolts in voice reception. This sensitivity is measured to a 10-1 signal-plus-noise to noise-power ratio.

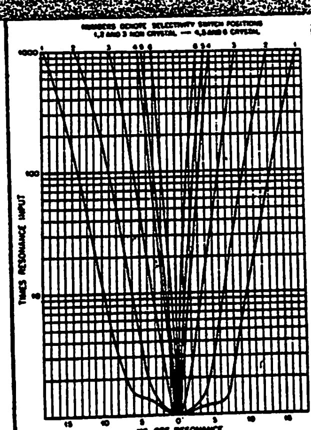
DIVERSITY RECEPTION—The SP-600 is designed also for use in a diversity reception system designed to enhance the quality of the communication link whenever the receiving conditions cause signal fade. In this case two or more of the receivers are used in close proximity to each other. The spatial separation of the receiving antennas provides a higher probability of a usable signal from at least one receiver at a given time. Space diversity receiving systems provide distinct improvements of high-frequency radio transmissions.

Each receiver has a cable connector to provide the received signal as IF output for space diversity system use. Radio transmissions as CW and single-tone modulation are used for Morse code operation while two-tone and frequency-shift modulation are used especially for teletypewriter operation.

While the standard model can be used in this way in a diversity system, a special model is also available. This model is designed to accomplish the following modes of operation.



Block Diagram of the Super-Pro 600



SP-600 selectivity curves overall at 2 megacycles

THE DRAKE R-7/R-7A RECEIVER:

An Outline of Major Features, Modifications and Accessories

David Clark with Jon Williams

R7

Synthesized
General Coverage
Receiver

Figure 1: The Drake R-7 (Model 1240) Receiver

INTRODUCTION

A general review of features, operating characteristics and performance of the Drake R-7 by Jerry Strawman appeared in *Proceedings 1988* (Strawman, 1988). This paper is not intended to supersede but rather to complement that original article and other earlier reviews which appeared in both the commercial and the hobby press (some of which are cited herein). Larry Magne's comprehensive reviews of the R-7 and its successor R-7A appeared in the pages of the 1980 and 1982 *WRTH* respectively. (Magne, 1980 & Magne, 1982) In a follow-up article in the 1984 *WRTH*, Magne discusses external devices that can really improve the operating characteristics of the R-7A. (Magne, 1984)

In 1984 the R.L. Drake Company ceased production of the R-7A receiver, as well as the other products in its amateur radio line in order to concentrate its energies on the rapidly emerging satellite television market. Drake fans, including the present authors, were of course very pleased when Drake reentered the HF hobby market in 1991 with the launch of the R8 receiver (see Elton Byington's comprehensive review in *Proceedings 1992-93*). Currently, serious broadcast listeners and DXers are blessed with a variety of "high-end" general coverage receivers to choose from, all of which are fully synthesized and offer many operating conveniences by taking advantage of microcomputer technology. In addition to the Drake R8 offering at $980, these include the Japan Radio NRD-535D at $1689 (reviewed by Robert Evans in *Proceedings 1992-93* and compared to the R8 by John Bryant in this edition), and the Lowe HF-225 Europa at $899 (reviewed by Chuck Mitchell in this edition). Finally, we have the latest "professional-grade" DSP marvel, the Watkins Johnson HF-1000 at $3799, which is also the subject of a "first impressions" review in this edition of *Proceedings*.

So why, a decade after it went out of production and given the excellent equipment currently on the market, we are taking another retrospective look at the R-7A? We offer several responses which reflect the objectives of this article. Apart from the aforementioned, somewhat cursory review in *Proceedings 1988*, virtually nothing has been printed in the hobby press concerning the R-7A since 1984. This is understandable but unfortunate, since many new hobbyists have joined our ranks in the last ten years and it seems likely that most would not have more than a passing acquaintance with this high performance, semiprofessional receiver. For those in the market for a cost-effective used but very capable communications receiver, a solid state model like the R-7A is going to be more reliable and easier to maintain than the earlier tube-type receivers.

Second, many longer term DXers who haven't had extensive "hands-on" experience with the R-7A may not have a full appreciation of some of the important features, capabilities and configuration possibilities offered by this unique receiver. Furthermore, a number of useful modifications and adjustments are possible that have not been widely publicized.

This paper is intended to assemble most of this important information together in one place. Notwithstanding the generally excellent performance and operating convenience of the current crop of top-end receivers, consider what Larry Magne wrote in 1982:

Is this the time to buy? Technically, for serious DXing there may not be another receiver available soon, if ever, to surpass the performance of the Drake R-7A. What progress that is taking place is largely in the realm of more fully-automated operation via greater use of internal microprocessors. The Drake R-7A, which requires above-average skill to operate to its full potential, is unsurpassed by any receiver tested in the ability to successfully flush out tough shortwave, mediumwave and longwave DX or SWL signals. (Magne, 1982) **For the most part, we think this statement remains relevant, even in 1994.** In a major user review of the Drake R8 that was published in *DX Ontario*, there is a table comparing the important performance characteristics of the R-7A, the R8 and the NRD-535D. (Clark, 1991)

Although it was certainly expensive and in some respects ahead of its time in today's dollar terms this receiver could easily cost $2500 or more. In 1979, the basic R-7 with only one standard eight-pole crystal filter for SSB, but including the DR-7 digital readout option, listed at $1295. The price increased to $1449 as of June, 1980 and then to $1549 by March, 1981. When the upgraded R-7A was released in late 1981, a second eight-pole crystal filter for CW was included, together with stock provision of a very wide AM bandwidth, the DR-7 digital readout/general coverage capability was incorporated and finally, the previously optional noise blanker was included in the standard offering. This also brought the base price up another one hundred dollars to $1649. A full configuration of five crystal filters with certain other necessary wiring modifications could be purchased for a package price of slightly less than $1800 until the R-7A was discontinued in 1984.

Back in mid-1980, Drake was also publicizing a forthcoming commercial/marine version of the R-7 which was to be called the MR-3. (Magne, 1980) It was to be a digitally-tuned (in 10 Hz increments) version of the R-7 utilizing an optical encoder, probably akin to the synthesized mechanism in the Japan Radio NRD-515. Unfortunately we have no further information about the fate of this model which had a targeted price-tag of $2200. What we do know is that the "professional-grade" model R4245 receiver (perhaps superseding the planned MR-3?) became available in 1981 at a list price of $3800. Despite the different physical design which catered to rack mounting, all the important features corresponded to those of the R-7A but for the distinction that it was fully-synthesized.

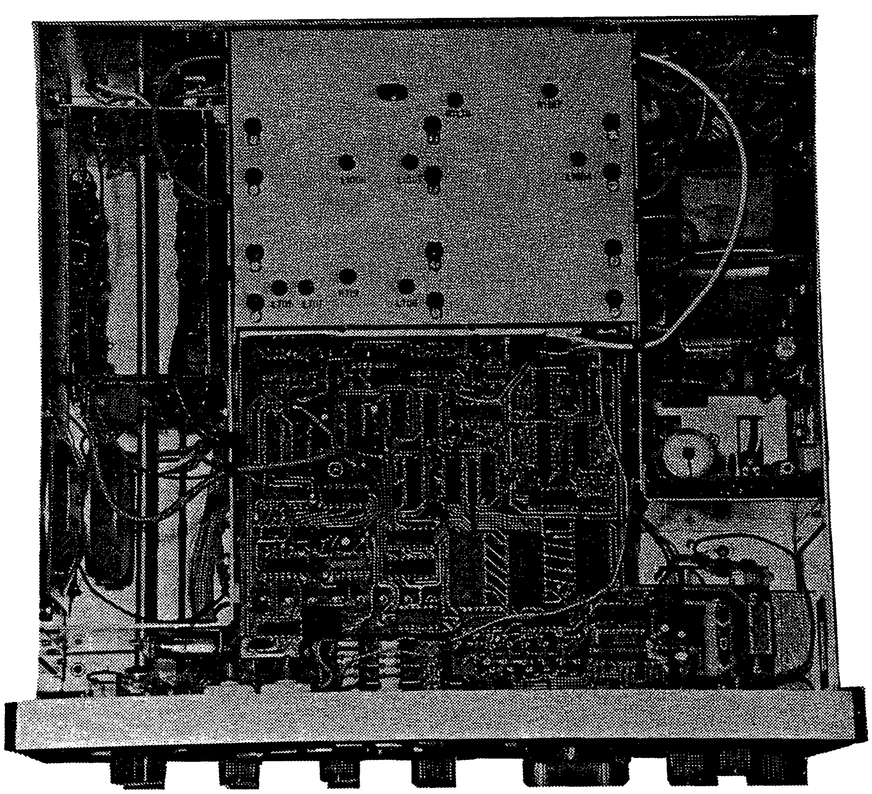


Figure 2: R-7A Top View (with cover removed)

Although they are not plentiful, sometimes an R-7 or R-7A with a full complement of IF filters, and possibly other options, shows up on the used market or at a hamfest in the $700 to $800 price range. **The R-7A is certainly not everyone's cup of tea. But as active DXers who still very much enjoy using this receiver, we think the price-to-performance value remains hard to beat. This is especially so for dedicated DXers who relish "working" all the twenty-five front panel controls the receiver places at their disposal to aid in that constant search for new and rare DX catches.** Guy Atkins concurs. He writes: *I am very much a "hands-on" DXer and I like to constantly fiddle with the controls to try and improve things. I enjoy the R-7 immensely in this regard.*

This is an appropriate point to extend a special thanks to Guy Atkins for his input and encouragement and to James Goodwin for his editorial assistance. Thanks also to Harold Sellers for his cooperation in digging out many of the older source references from the ODXA archives!

SERVICE MANUAL/DRAKE SERVICE DEPARTMENT

In the course of preparing this article, we found that a thorough reading of the Service Manual was useful. Apart from the usual full documentation of the receiver operation and alignment procedures, certain adjustments are described to maintain or improve particular performance and operating characteristics. The manual is also essential if user modifications are to be undertaken. The original R-7 Service Manual sold for $30 and for the R-7A the price was $35. Unfortunately the manuals are no longer in stock at the company. *If a used receiver can be purchased with the Service Manual as well as the standard Operating Manual, that is a bonus. When Guy Atkins and I visited the Drake Service Department in August, 1994, we learned that consideration had been given to reprinting the manuals but at today's prices, the cost would have been prohibitive. (DC)*

The good news, however, is that the Drake Service Department continues to provide expert alignment, parts and service support for the R-7A. *On the occasion of our visit, Guy and I spent the better part of an hour talking with John Andrews who is the man to deal with when it comes to the R-7A. We found him to be very knowledgeable and helpful. At this time, I turned over both of my R-7's to John for a complete overhaul and alignment which was estimated to require three hours each for labor. At the current hourly rate of $74, plus parts, one can expect to have Drake bring an R-7A receiver up to peak operating performance for about $250. I consider this to be an excellent long term investment. (DC)*

Drake has relocated from Miamisburg to nearby Franklin, Ohio but the direct line to the Service Department remains the same: 513-866-3211.

Figure 2 shows a topside view of the internals of Jon Williams' R-7A. The center-rear plate covers the IF Selectivity Board, Passband Tuning/Reference Oscillator Board and the 2nd & 3rd IF/AGC Board. Although the design features modular construction with discrete functions on separate printed circuit boards for easy servicing and alignment, notice also that there is still extensive use of point-to-point wiring.

DR-7 DIGITAL READOUT/GENERAL COVERAGE BOARD

The R-7 was first released in the Fall of 1979, modelled after but improving upon the receiver section of the TR-7 transceiver which came on the market one year earlier. Features such as a switchable preamp, a notch filter and "synchro-phase" AM detection upgraded the R-7 compared to its TR-7 sibling. In its stock form, the original R-7 listed at $1100 but did not provide full general coverage reception capability. The tuning range was limited to .01-5.5 MHz (excluding 2.0-2.5 and 4.0-5.0 MHz) and additional 500 kHz HF segments covering the 40, 20, 15 and 10 meter ham bands. It was necessary to add the $195 accessory DR-7 module to obtain full frequency coverage from .01-30 MHz. The DR-7 also included a counter circuit to provide digital frequency readout to the nearest 100 Hz in a 7-character LED display.

The original version of the receiver equipped with the optional DR-7 module was known as the R-7/DR-7 (and then briefly as Model 1240). While we don't have exact knowledge of the situation, we suspect that very few of the stock R-7 version were sold, even to hams, and it was probably discontinued rather quickly. Before long, the distinction between analog and digital versions disappeared and the latter became known simply as the R-7. Most R-7's (and all R-7A's dating from late 1981) which are to be found on the used market are fitted with the DR-7 module and many hobbyists may not even realize the original distinction. So, for the purpose of this article, generic references to either or both (i.e.. R-7A) models are deemed to include the DR-7 digital readout/general coverage board.

A rear panel connector controlled by a front panel switch is provided which also allows the digital readout to serve alternately as an outboard 150 MHz frequency counter. In *Proceedings 1989*, Cedric Marshall described a simple procedure whereby an insulated wire can be wrapped around the oscillator coils of a tube-type receiver to act as an inductive pickup loop. It is then fed by coaxial cable to the counter input using a phono plug. The R-7A digital display then shows the operating frequency of the tube receiver, incremented by its IF (e.g.. 455 kHz or 3035 kHz in the case of a Hammarlund HQ-180/A, depending on the band selected). (Marshall, 1989)

THE AUX-7 AUXILIARY PROGRAM BOARD

Complementing the general coverage provided by the DR-7, the AUX-7 Range Program/Fixed Frequency Board Model 1536 allows specific selection of up to 8 different frequency ranges of about 750 kHz (nominally 500 kHz) each. This is similar in function to the additional crystal-controlled ranges on the Drake R-4 series receivers. The AUX-7 makes for much greater operating convenience because it can be programmed to cover the SWBC or other HF band segments tuned most often by the DXer or SWL. Normal VFO operation or range selection is provided by the Auxiliary Program switch and a Setband status LED indicates the need to set the Band switch to the proper range when using the AUX-7.

This highly desirable accessory alleviates the need to use the cumbersome 'Up/Down' pushbuttons to step in 500 kHz increments from one of the eleven preset ranges to reach the desired frequency band. As we have noted, except for longwave, medium-wave and the 90 meter Tropical Band, most of the other preset ranges cater to the HF ham bands between 160 and 10 meters. Without the AUX-7 installed, the worst case scenario for SWL's is the necessity to set the Band switch at 21 MHz and to depress the 'Down' button no less than twelve times to reach the 19 meter SWBC band. Just imagine the tuning gymnastics required if trying to check parallels on different bands! It seems surprising how many R-7A's were apparently sold without being fitted with the AUX-7.

There is also provision for a fixed frequency crystal to be used within each AUX-7 range. This feature was probably provided with amateur radio net operations or certain commercial applications in mind. Selection of VFO or AUX-7/fixed frequency operation is controlled by a front panel switch.

The AUX-7 originally sold for $45, and can sometimes be found separately but usually without the appropriate RRM-7 frequency range modules. The modules originally cost $8.50 each, but Drake has not carried them for some time. They are, however, easily made for the desired frequency ranges by purchasing 14-pin headers and IN4148 diodes from an electronics supplier. Headers with brass pins which extend above the top surface of the header are best. The modules are made by soldering diodes to the pins in various combinations corresponding to the desired frequency range. A copy of Drake's module chart is necessary to determine these locations. This home-brew project requires time, patience and careful micro-soldering, but the added band-switching convenience makes it well worth it for serious DXers and SWL's alike.

ANTENNA SELECTOR/SPLITTER CONFIGURATIONS

A unique feature of the R-7A is the rear panel provision for up to three separate and well-isolated antenna inputs. The six-position, front panel Antenna switch allows two antennas to be used in any combination with the R-7A and another receiver. The built-in splitter allows the R-7A and another receiver to operate concurrently off the same antenna. One antenna input/switch position labelled "Converter" is for the R-7A only and renders 75 dB of isolation to guard against unwanted interaction with the other antenna positions. So, this is the position one would use with a dedicated BCB or Tropical Band loop antenna when DXing with the R-7A.

In a user review written for the National Radio Club, Craig Healy points out that by connecting one antenna to 'Main', another antenna to 'Ext Rcvr' and by setting the selector switch to the 'Main/Main' position, the antenna splitter works as a combiner. This enables the use of two phased longwires or a longwire in combination with a loop. (Healy, 1982) This capability will be of particular interest to BCB DXers.

The layout for connections on the rear panel is awkward and one has to take care when making various connections. There are eight, closely-spaced RCA phono jacks for various inputs and outputs, including the three antenna inputs and the output for an external receiver. Typically this requires extensive use of RCA jack/SO-239 adaptors. Guy Atkins has a better idea. He suggests homebrewing a junction box that could be attached to the rear panel with provision of appropriate SO-239 inputs. Another approach Guy suggests is to make up a wiring harness consisting of short (say six inch) lengths of coax terminated with gold-plated RCA plugs and sheathed SO-239's. This would mean the RCA plugs could remain "permanently" connected to the receiver to eliminate wear and tear to the inputs and would make for more convenient changes to antenna/external receiver connections when desired.

FULL ELECTRONIC PBT

One of the great features of the legendary Drake R-4 series that was provided in an improved form with the introduction of the R-7 was what Drake called "full electronic passband tuning" that was operative in all detection modes. The R-4B rendered full passband tuning mechanically, while the R-4C introduced electronic passband tuning but it was inoperative in AM mode. (Williams, 1989) **The version of PBT in the R-7A offers the best of all possible worlds.**

The PBT control is connected to a 13.695 MHz voltage-controlled crystal oscillator and varies the frequency of the oscillator within a range of approximately +/- 4.5 kHz (nominally +/- 3 kHz). Since the oscillator is used to generate both the 5.645 MHz 2nd IF and 50 kHz 3rd IF injection signals, the operating frequency of the receiver remains constant when the frequency of the oscillator is varied by the PBT control. Thus the 2nd IF can be positioned anywhere within a +/- 4.5 kHz range with respect to the filter passband while the receiver remains tuned to the operating frequency.

Unlike the provision for 'Passband Tuning' or 'Passband Shift' in certain other "modern" receivers, the R-7A PBT operates in AM mode thanks to the synchro-phase detection scheme. It has sufficient range to make it continuously variable either side of the "12 o'clock" position between the upper and lower sideband components of an AM signal, or for positioning the 2nd IF filter skirts anywhere within the IF passband for optimum reception of a signal being detected in SSB/ECSS or CW mode. Front panel markings indicate nominal USB/LSB settings for each mode.

Depending on the degree of adjacent interference, one should select the widest possible filter for optimizing the audio response which still allowing an unwanted interfering signal to be positioned outside the receiver passband. Any remaining closely-spaced heterodynes can then be nulled with the tunable notch filter. **When complemented with a full array of IF crystal filters, combined with judicious use of the notch filter), the flexible PBT arrangement of the R-7A is both convenient for SWLing and virtually unbeatable for "tough signal" DXing!** We should perhaps add a future caveat. If full, all-mode passband tuning is properly implemented with a software upgrade, the new Watkins-Johnson HF-1000 has the potential to set the new standard of performance. The DSP filtering capability already provided in the HF-1000 is an incredible technical advance...at a price, of course.

By way of comparison, the Passband Shift in the Japan Radio NRD-535D only allows the center frequency of the selected IF filter to be adjusted +/- 1 kHz without changing its overall bandwidth and it does not work well in ECSS mode. Furthermore, the 535's notch filter is not effective in AM or ECSS mode. (Evans, 1992) To a certain extent, these "sins" are compensated-for by JRC's improved, all-mode Variable Bandwidth Control.

In the case of the Drake R8, the Service Manual outlines the circuitry to provide the passband tuning function (now called Passband Offset) that is essentially the same in design as outlined above for the R-7A. The Passband Offset control is operative in AM or AM Sync modes and has sufficient range (nominally +/- 3 kHz) to cover both the upper and lower sidebands without detuning the operating frequency. Unfortunately it does not work quite so well when tuning broadcast signals in the ECSS mode.

Perhaps due to a design idiosyncrasy or an alignment procedure that may vary slightly from one unit to another, the positioning of the passband offset seems to be "unbalanced" in the sense that it is not possible to shift into the lower sideband if the mode selected is USB. By selecting LSB, however, I have found it is possible to recover most of the upper sideband component by adjusting the Passband Offset control between the "3 o'clock" and "5 o'clock" positions. I always keep the R8 in LSB mode for ECSS DXing so I can readily shift between upper and lower sideband without the inconvenience of scrolling from one mode to the other. The R8's audio notch is operative in all modes too, but it is more tricky to use and somewhat less effective than the IF notch of the R-7A. (DC)

IF FILTER CONFIGURATIONS

The standard R-7 came equipped with only a 2.3 kHz SSB/ECSS eight-pole crystal lattice filter in the 2nd IF. This filter has an excellent shape factor rated at 1.8:1. It is installed on the 2nd & 3rd IF/AGC board. A separate IF filter board provides for up to four additional accessory crystal filter positions in the 2nd IF. It is worthy of note that any IF selectivity position can be utilized independent of mode. This flexibility is a big improvement over Drake's predecessor R-4 series and SPR-4 model. The optional eight-pole crystal filters with 2:1 shape factors available from Drake (originally costing $52 each; $60 by 1982) were 6 or 4 kHz intended for AM, 1.8 kHz for narrow SSB/ECSS, and 500 or 300 Hz for CW. The original R-7 Operator's Manual (printed in 1979) did not contain an illustration of the IF Selectivity Board but an updated version of the manual (dated 5-80) does contain a half-page illustration showing the proper installation sequence of the optional filters on the board.

Soon after the R-7 came on the market, Sherwood Engineering offered a high quality eight-pole crystal lattice filter with a 3 kHz bandwidth and a 1.8:1 shape factor. Eventually, Sherwood offered a full range of filters (costing $80 each) for the R-7A. The other bandwidths were 6, 4, 1.6, .5 and .2 kHz. All of the Drake or Sherwood filters featured excellent deep-skirt selectivity characteristics, thus rendering ultimate selectivity of better than 100 dB.

The R-7 manual contains instructions whereby the user can install a 150 ohm, 1/2 watt resistor jumper in the 4 kHz selectivity position. In the absence of the optional 4 (or 6) kHz filter in this position, that modification rendered very wideband AM selectivity of 8-10 kHz derived solely from the four-pole monolithic, crystal bandpass filter in the 1st (48.05 MHz) IF stage.

As explained in the manual, *the [primary] purpose of this filter is to attenuate signals removed more than +/- 4 kHz from 48.05 MHz, thus protecting the remaining stages of the receiver from strong interfering signals. In this manner, optimum receiver dynamic range is preserved while providing excellent sensitivity.* Drake advertising hailed the special front-end circuitry employing a high-level double balanced mixer and 48 MHz "up-converted" 1st IF as a significant advance in both image rejection (rated > 80 dB) and strong signal-handling characteristics. **Excellent sensitivity and selectivity, combined with superior dynamic range, are hallmark characteristics of the R-7A. Taken together, they are very important to DXers seeking to pull in weak signals through other stronger, closely-spaced signals on medium wave, as well as on the Tropical and HF SWBC bands.**

The rated Third Order Intercept Point (above 1.8 MHz) is an outstanding figure of +20 dBm with preamp off. When the 10 dB RF preamplifier is switched in, the figure is still a very good +10 dBm. These values are based on 100 kHz signal spacing. A review in *QST* magazine reported **worst-case** dynamic range performance was found to be on 80 meters where the Third Order Intercept Point tested out at +17 dBm with preamp off and -2.5 dBm with the preamp on. (DeMaw, 1980) The figures for preamp on/off were transposed in the original review article but corrected in an editorial note in the subsequent monthly issue of the magazine.

With the R-7A, the standard selectivity configuration was upgraded to include both the 2.3 kHz and the 500 Hz crystal filters, as well as factory-installed provision for the 8-10 kHz wideband AM position. On the assumption that the purchaser might take advantage of all five potential selectivity positions, the R-7A front panel Selectivity control positions are labelled (clockwise) as 4, 2.3, 1.8, .5 and .3 kHz.

Many shortwave broadcast DXers and SWL's, however, were not concerned with CW reception capability. They purchased their R-7 or R-7A from suppliers such as Gilfer Shortwave which offered a modified version, fully configured with five voice bandwidths. Perhaps the ideal combination of Drake/Sherwood filters rendered a bandwidth selection of 6, 4, 3, 2.3 and 1.8 kHz. Proper sequencing of the filter selection via the Selectivity switch necessitates several internal modifications. In this configuration, the 2.3 kHz filter has to be rewired onto the IF selectivity board and the 4 kHz filter is installed in its place. In addition, with the R-7A, the stock 500 Hz CW filter has to be removed. Then, an audio filtering circuit automatically invoked when the Selectivity switch is placed in the original 500 or 300 Hz positions should be disabled. This circuit is intended to optimize CW reception quality by lowering the overall high frequency response. To compensate for greater insertion loss when the narrow CW filter positions are selected, additional gain (about 5 dB) is automatically applied in the 2nd IF stage. In this modified configuration, placement of the 2.3 and 1.8 kHz filters in the designated CW positions on the filter board means that this additional amplification partially offsets the insertion loss at these narrow voice bandwidths.

It is clear that the asking price for an R-7A is going to be governed by the auxiliary filters already installed. We **think any prospective purchaser would be well-advised to pay the "premium" that will be dictated by a full array of filters, especially if the Drake 4 kHz and/or the highly-prized Sherwood 3 kHz filter are included.** The 4 kHz Drake filter is ideal for selectable sideband reception utilizing the synchro-phase AM detector. This form of AM demodulation is superior to the more usual diode detection method for AM signals, rendering less distortion and as noted above, allowing the electronic PBT to be utilized in AM mode. Conventional (double sideband) AM detection renders only about 2 kHz of audio bandwidth through a 4 kHz filter. The synchro-phase detection scheme allows more like 3 kHz of audio bandwidth through the sideband least subject to interference, thus rendering greater intelligibility . This is essentially the same effect that is realized when using the product detector to tune in the more complex ECSS mode.

The 3 kHz Sherwood filter bridges the gap nicely between the Drake bandwidths of 2.3 and 4 kHz. We have found this filter to be optimal for ECSS tuning under nearly all reception conditions except when "close-in" interference is extreme. *Some years ago I was fortunate enough to walk into Universal Radio, Reynoldsburg, Ohio the very day that an R-7 had been taken in on trade for what was then a spanking new NRD-525. This particular R-7 had been serviced and modified by Dr. J.R. 'Doc' Sheller, KN8Z of Design Electronics in Ohio. His firm was well known for its expertise with Drake gear. The filter configuration was quite unique. The provision for wideband (8-10 kHz) AM was retained, while the other filters were the Drake 4 and rewired 2.3 kHz, complemented with the Sherwood 3 and 1.6 kHz values. The hastily assigned resale pricetag of $600 did not properly reflect the inherent value of the auxiliary filters (especially with the inclusion of the Sherwood 3 kHz!) and I knew it. To his credit, Universal's Fred Osterman graciously allowed me to purchase the receiver on the spot for the "bargain" price as marked. It would still have been a very fair deal at $750. I DX in the ECSS mode almost exclusively and the bandwidth filter switch rarely moves from the 3 kHz position. That Sherwood filter is a gem! (DC)*

The 1.8 (and possibly the 6) kHz filter is still available from Drake but the most desirable 4 kHz Drake filter and 3 kHz Sherwood filter are no longer available from the original sources. Drake's 6, 4 and 1.8 kHz filters occasionally appear in the Ham Trader Yellow Sheets or at flea markets, but we have never heard of the 3 kHz Sherwood filter being offered separate from one of the relatively few receivers in which it is installed. Substitute filters from other sources are not readily available either because the R-7A uses an unusual 2nd IF of 5.645 MHz.

I finally gave up looking for the Sherwood 3 and ordered a comparable, custom-built 8-pole from International Crystal and Radio in Florida at a premium cost of about $180. It took about four months to arrive from Japan but the investment and the wait were worth it. The performance is comparable to Sherwood's version and believe me, it is the only filter for ECSS DXing. I use it about 80 to 90% of the time, even for casual listening. (JW)

Like David, Guy Atkins uses both the Drake R-7 and the R8 for serious DXing and he compares their selectivity capabilities as follows: *The receivers are used here in head-to-head DXing situations for both difficult shortwave Tropical Band and trans-Pacific mediumwave DX. I prefer the R-7's IF filters. They have better ultimate rejection which I've proved to myself time and again while mediumwave DXing faint T-P stations between the domestic channels. I want to emphasize, however, that unless you are seeking extremely difficult DX, the R8's L-C filtering is very good, especially in conjunction with the passband offset and notch controls. The R8's filters do contribute to its very good audio because of the low distortion inherent in well-designed L-C filters.*

Note that for voice bandwidths less than 3 kHz, some audio distortion is experienced with the R-7A in AM mode. Since audio response is optimized for SSB detection in any event, tuning in ECSS mode is preferred for best intelligibility, especially if a narrow bandwidth filter is being used. Most reviewers subjectively rate audio reproduction in AM mode as adequate (albeit much-improved over that of the predecessor R-4 series and SPR-4); good at 4 kHz or wider bandwidths. There is almost universal agreement that audio in SSB/ECSS mode (at 3 kHz or less) is excellent.

RIT TUNING RATE MODIFICATION

The tuning rate of the stock receiver incremental tuning control (RIT) is quite coarse, at about the same rate as the main tuning knob, across its analog range of +/- 3 kHz. This makes ECSS tuning "touchy" and quite cumbersome with the small concentric RIT tuning knob. Steven Lare brought to our attention a modification that originated with Malcolm Chisholm and was published in David Newkirk's 'Radio Equipment Forum' column in *Review of International Broadcasting*. (Chisholm, 1984)

The idea is to connect a resistor of an appropriate value across the two poles of the RIT control circuit which can be accessed easily from the bottom side of the main circuit board. As Chisholm described it, look for three solder points and a conductor strip labelled 'PTO' and '37' at top-center of the board. An inch to the left and an inch below that group there is a series of coloured wires which are soldered from the control panel to the main board. Looking from right to left, the first two wires (green and grey) are the outside terminals of the RIT control and a resistor can easily be soldered across them.

This modification changes the RIT tuning range to a value in Hertz which is approximately equal to the value of the resistor employed. John installed a 470 ohm resistor and this renders an RIT range of about 470 Hz (+/- 235 Hz). James Goodwin modified both of David's R-7's using a 1/2 watt resistor of about 220 ohms in each case. This is quite sufficient to enable easy and precise ECSS tuning, provided the signal is initially tuned to the nearest 100 Hertz increment with the main tuning dial. Except for the change in range, normal operation of the RIT is maintained so that a change in frequency (to the nearest 100 Hz) will continue to be shown on the digital frequency display.

James found that this modification may necessitate a circuit realignment so that, with the RIT tuning knob set at its mid-range point, switching the RIT on and off does not cause a change in the frequency displayed. Specifically, switch on the RIT and set the RIT tuning knob to the center of its range (indicator straight up). With both SSB/CW mode and the 25 kHz Calibrate function switched on, tune in and zero beat a calibration signal. Then switch off the RIT and adjust potentiometer R24 for zero beat. The slotted adjustment for this pot is accessible through a hole in the bottom side of the main board near where the strapping resistor was soldered. The provision to adjust the RIT center position is not mentioned in the Operator's Manual but is cited in the Service Manual.

A slightly more complicated modification to accomplish the same effect is described by Vincent J. Pinto in his article 'Receiver Notes #1' in *The LOWDOWN*. (Pinto, 1984) Pinto's approach required connecting two like resistors from each end terminal of the RIT pot to the center wiper of the pot. Using resistors having a value of 4000 to 5000 ohms for example, would reduce the RIT tuning range to about one-third of its stock range. A re-alignment of the RIT centering is then required as outlined above.

The RIT tuning range modification is highly desirable for the DXer, unless one enjoys the luxury of a Drake RV75 External VFO (discussed in a following section), because it makes SSB/ECSS zero-beating far easier - comparable in result to the familiar Bournes pot modification of the Delta Tune (RIT) control on the Japan Radio NRD-515.

NOTCH FILTER OPERATION AND ADJUSTMENT

The general consensus among R-7A users who also have experience with the predecessor Drake R-4 series or some of the older Collins and Hammarlund tube-type equipment is that the tunable IF notch is quite effective but not quite up to the same level of notching capability of those older receivers, or indeed, Drake's SPR-4. As noted, however, the R-7A notch is easier to tune and exhibits a greater notch depth than the AF notch on the Drake R8.

The notch filter circuitry functions in the 50 kHz 3rd IF and is capable of eliminating or at least significantly attenuating a single interfering heterodyne within +/- 4 kHz either side of a signal being received. Its operation to position the null within the passband is described in the Operator's Manual: *Merely tune for minimum interference from the unwanted signal by listening for the audio null and observing the S-meter dip. The knob rotation sense is such that when the PBT control is clockwise of center, the notch control is clockwise of center and vice versa. Although the S-meter dip indicates only 20 dB notch depth, the actual audio null can be adjusted to approximately 40 dB depth.*

By reference to the Service Manual we find that two adjustments are possible on the 2nd IF board. The coil of variable can inductor L1104 can be adjusted to center the front panel notch control pointer when the 3rd IF is properly aligned at 50 kHz. The pot of variable resistor R1147 adjusts the circuit gain to provide maximum signal null at any resonant notch frequency.

Even in the absence of an interfering heterodyne, adjustment of the notch filter, in conjunction with the passband tuning control, can be very useful in shaping the audio response for optimum readability, especially when a narrower bandwidth is required. (DC)

AGC CONFIGURATIONS

The R-7A features four AGC positions: 'Fast' (75 milliseconds), 'Medium' (400 milliseconds), and 'Slow' (2 seconds) time constants, as well as 'Off'. Selection is determined by the "in" or "out" positions of two front panel switches in combinations which are not intuitively obvious. For example, with both switches in the "out" position, AGC response is 'Slow'; with both switches in the "in" position, the AGC is 'Off' and subject to manual control with the RF gain.

The two AGC pushbuttons must be handled very carefully. If an incorrect setting is used the receiver will either deliver distorted audio or produce no output at all. On the other hand, this AGC circuit can eliminate most flutter and fading phenomena when used sensibly. The S-meter is very accurate and its characteristics are geared to the AGC circuit. (Lichte, 1985) The sparse operating instructions in the manual do not give any guidance as to which time constant should be used for different modes/reception conditions. Most users agree that either Slow or Medium works well for AM or SSB/ECSS reception. AM and stronger SSB signals suffer distortion in Fast mode unless the RF gain is backed off (counterclockwise) to at least the "3 o'clock" position. Craig Healy was advised by Drake that the Fast mode is intended mainly for reception of CW transmissions with full break-in. (Healy, 1982) For very weak signal reception, especially under difficult noise conditions, sometimes it pays to switch to the Off position, set RF gain between "11 o'clock" and "1 o'clock", and then vary the signal level with the AF gain control.

NB7A NOISE BLANKER / EXTERNAL BLANKER ENHANCEMENT

The noise blanker was a $90 extra cost option for the R-7 but was incorporated as standard equipment with the R-7A. According to the manual, it mutes the receiver for the duration of a noise pulse and between pulses, full receiver gain is restored so that the AGC is affected only by the desired signal and not by the noise. The blanker is claimed to be most effective on strong, periodic noise pulses such as automobile ignition noise.

In his evaluation, Craig Healy reported no evidence of audio distortion (Healy, 1982), although most other reviewers acknowledge and we also find there is a tolerable degree of distortion when the blanker is used, especially in AM mode. There is no provision for varying the threshold level as is common in more recent receivers. Healy also reports finding no evidence of spurs or intermodulation noise in the presence of strong signals as he experienced with another (unspecified) maker's blanker (Healy, 1982)

In his article 'A Synchronous Power Line Noise Blanker', Vincent Pinto outlines the construction details of a homebrew, external synchronous noise blanker which drives the internal IF blanker of the R-7A. He explains that there are two reasons why even good built-in blankers, including the NB7A, will typically remove only 3 to 12 dB of power line (or light dimmer) 120 Hz noise pulses. *Noise blankers look for a sharp short pulse with a fast rise time. Power line noise, on the average, exhibits a broad pulse with a relatively slow rise time...Secondly, noise blankers generally create a short duration blanking pulse, much shorter than the pulses frequently encountered in power noise signatures.*

The external blanker is highly effective because it derives its blanking pulse directly from the power line frequency. Provisions are made to adjust the phase (ie. delay) of the 120 Hz pulses to coincide with the noise pulses, and to adjust the blanking pulse width and level. The author reports spectacular results: *The addition of the synchronous blanker has worked a miracle. Although there still are a few times I can't get rid of all the noise, it usually is completely effective.* (Pinto, 1983)

The only problem with this article is that the "accompanying schematic" was not printed. The article was subsequently reprinted in *Monitoring Times* (Pinto, 1985) and includes the essential schematic.

MEDIUM-WAVE PERFORMANCE AND SENSITIVITY ADJUSTMENT

The superlative capabilities of the R-7A for DXing on the Tropical Band and the HF SWBC bands are well known and scarcely need further comment. But this is also a much better receiver for medium-wave DXing, including foreign "splits", than perhaps has been generally recognized. The 10 dB RF preamp is not operative below 1500 kHz (see Enabling RF Preamp in next section), and yet sensitivity in the 500 to 1500 kHz range is specified as less than 4 microvolts for a 10 dB S+N/N ratio in AM mode and less than 1 microvolt in SSB mode. These are excellent values.

Apparently the R-7A is capable of delivering even better medium-wave sensitivity than specified, based on the way in which it was delivered from the factory. The Operator's Manual explains: *For AM reception within the 0.5 to 1.5 MHz range the following applies. Because of the wide variation in antennas used on this range, an attenuator pot (R1502), located on the input filter module, is provided to allow the R-7A to be optimized for the particular antenna in use. This adjustment is factory preset to the middle of its range, and as such, reduces the sensitivity within this band. To increase or decrease the sensitivity simply adjust the pot (accessible from the top of the radio after removing the wraparound cabinet) while observing the S-meter reading. The location of the R1502 adjustment is shown on the top view (covers removed) illustration in the manual.*

Weak-signal reception capability is complemented of course by outstanding selectivity and the receiver's superior dynamic range. Even in strong signal environments it is virtually immune to overload and spurious signals on the HF bands, and medium-wave performance is almost as good. In this *1980 WRTH* review, Larry Magne enthused that the R-7's medium-wave dynamic range not only comfortably exceeded any other solid state receiver of the day but also *equals that of many of the best tube-type receivers tested in years past.* (Magne, 1980) Strong testimony indeed!

Craig Healy does point out, however, that the prescribed 500 kHz ranges in combination with the front-end bandpass filter configuration cause degraded sensitivity towards the upper limit of the BCB. (Healy, 1982) The arrangement of the bandpass filter module is not cited in the Operator's Manual but is outlined in the Service Manual. A lowpass filter is used for Band 1 longwave (10-500 kHz) and another lowpass filter is used for medium wave Bands 2 and 3 (500-1000 kHz and 1000-1500 kHz). The low frequency cutoff point for this filter is 1650 kHz, so signals up to about 1545 kHz (the limit of frequency overtravel on Band 3) are received well. For Band 4 (1500-2000 kHz) and the HF spectrum ranges up to 30 MHz, hi/lowpass filters are used.

In the particular case of Band 4, the low cutoff frequency is 1750 kHz, right in the middle of the prescribed tuning range. The Service Manual explains: *This is necessary to provide sufficient rejection to strong AM broadcast signals which can create interfering intermodulation products in the 160 meter amateur band. As a result, sensitivity may be degraded below 1.75 MHz in this bandswitch position.* Healy found that a local station on 1540 kHz could be received at 10 dB over S-9 on Band 3, whereas on Band 4 the signal was reduced to S-8, even with the preamp switched on.

Obviously an unmodified R-7A is not the best of receivers for DXing the top 150 kHz of the medium-wave band which is now extended domestically up to 1700 kHz. I certainly experienced its limitations in this range when DXing the 500 watt Australian print-handicapped services that used to occupy 1620 and 1629 kHz. Before they reverted to "conventional" channels below 1600 kHz, these stations were heard with quite readable audio on a number of occasions in the early 1990's from my Newmarket, Ontario DX site. The receiver was a Japan Radio NRD-515. Comparatively, only moderate strength carriers could be detected on an R-7 using the same antenna. (DC)

Apart from the sensitivity limitation at the top end of the band, Healy rated the BCB performance of his R-7A as *at least as good as the [Collins] R-390A.* He noted that longwave performance was quite good as well. (Healy, 1982) His comments suggest he did not have one of the very early production units.

The initial production versions of the R-7 suffered from power line "birdies" and spurious responses on longwave and to a much lesser extent on medium-wave. These gremlins were largely corrected in later production runs. In a courteous letter dated November 21, 1979 to Larry Brookwell, Neil LeSaint, the Drake Project Engineer, confirmed two production modifications. In receivers with serial numbers above 200, a capacitor (1000 mF) was added to the power supply board to reduce internally generated signals in the 500 kHz to 1600 kHz range to typical levels of less than a 0.4 microvolt equivalent. It was also acknowledged that spurious signals +/- 22 kHz either side of the receiver frequency could arise due to conducted energy from the power supply converter. In receivers with serial number above approximately 150, a choke and capacitor were added to the parent board to improve the typical rejection characteristic to 80-90 dB or greater. (LeSaint, 1979) True to form, Drake accepted returns of the deficient sets and rectified the problems. *When I visited the Service Department in August, 1994 I learned that Drake can still retrofit early models with the newer power supply board (part #2100418), if required. (DC)*

The Specifications section in the manual indicates that the nominal 50 ohm antenna impedance is automatically switched to 200 ohms in the 10-500 kHz longwave tuning range. In his original *1980 WRTH* review of the R-7, Larry Magne states that the shift to the higher impedance occurs when the receiver is tuned below 1500 kHz (Magne, 1980) which would seem more logical. Unfortunately the Service Manual is silent on the point so we are uncertain what the antenna input impedance actually is within the 500 to 1500 KHz tuning ranges.

ENABLING RF PREAMP BELOW 1500 KHZ

Vincent Pinto also describes the modifications necessary to enable the preamp to operate on Bands 1, 2 and 3, and to extend the low frequency range of the preamp down to the 160-190 kHz longwave band for DXing low power beacons. He writes: *The RF preamp is normally disabled below 1600 kHz by removing the d.c. return path for the amplifier transistor when the bandpass filters for bands 1, 2 and 3 are switch selected. To re-enable the d.c. path, I added a small 47 mh RF choke in series with a small 250 uh RF choke from the switch side of R1303 (near Q1301, the preamp transistor in the bandpass filter module) to ground. The RF chokes should not have excessive d.c. resistance, although it's not critical to have a very low resistance. A total resistance of a few hundred ohms or less from R1303 to ground is okay. Now the preamp will be enabled on any band when you hit the preamp "on" switch.*

Now we must lower the low frequency range of the preamp circuit so it has some decent gain at 170 kHz. This is very simple. You'll need two .02 mfd disc ceramic or mylar capacitors. Add a .02 disc ceramic capacitor in parallel with C1305 and one in parallel with C1307. Both capacitors are on the bandpass module/preamp board. They are on page 12-80 of the R-7A technical manual. You're done. The useful gain range of the preamp will now extend down to at least 130 kHz.

Pinto concludes: *My "new" preamp works perfectly well on longwave...I was a bit concerned about noise floor figure, but day to day use has shown no discernible change in the receiver noise floor with the preamp enabled on low frequencies...the Drake is dramatically improved in extremely weak signal CW work by the use of this preamp.* (Pinto, 1984)

PTO STABILIZATION MEASURES

While the R-7A uses a frequency synthesizer for control of the operating frequency, it is properly classified as a semi-synthesized receiver because it uses a Permeability-Tuned Oscillator (PTO) or VFO for signal injection to the synthesizer circuitry. The PTO frequency is varied linearly within any 500 kHz range by the main tuning knob. Although the PTO is temperature-compensated and calibrated at the factory, frequency stability cannot compare, especially during the warm-up period, with that of the fully-synthesized receivers that are now commonplace.

The R-7A does not have the greatest reputation for frequency stability. It is fair to say this problem is confined mostly to the first hour or so of operation from a cold start. Nevertheless, drift of 100 Hz or more is a definite nuisance, especially for DXers using the ECSS mode. The ideal solution would be the Drake RV75 outboard synthesizer or the Sherwood SE-4 stabilizer (described in following sections), but neither of these are likely to be available to the majority of receiver owners.

A partial remedy to the stability problem is to leave the receiver powered on at all times. In that case, operation from a DC power source (as below) ought to be considered to prolong component life since the receiver tends to run quite "hot" on AC power. Ben Hester suggests that some internal heat can be reduced by removing the 14 volt analog dial pilot light. It is placed quite close to the PTO and thus could contribute to the instability problem. Visual readout of the analog dial is not really required given the digital readout.

In his *1980 WRTH* review of the R-7, Larry Magne provides two tips to help ensure maximum PTO stability. He says to *check whether the VFO's worm gear is lubricated. If not, carefully work into its threads a very thin film of good machine oil or comparable lubricant. Too, the VFO shaft spring's tension can be increased by mounting the eye hook on the opposite side of the sliding vertical shaft. These two small measures are useful in order to maintain optimum stability.* (Magne, 1980) *Lubrication of the worm gear is not addressed in the Service Manual but I mentioned this point to John Andrews at Drake and he certainly knew what I was talking about.* (DC)

Then in his *1982 WRTH* review of the R-7A, Magne further advises that *active users may also find that occasional tightening of the PTO torque helps to maintain stability.* (Magne, 1982) The somewhat complicated disassembly procedure to gain access to the PTO adjustment hole is outlined in the Service Manual. A long, 3/32" Allen wrench is required to adjust, for the required tuning torque, the internal set screw which serves as the shaft bearing. Care must be taken, however, to avoid overtightening of the set screw to prevent bearing damage.

After taking steps to minimize frequency drift, it is aggravating if the tuned frequency readout is not quite accurate. The alignment procedures in the Service Manual include a simple method of correcting the readout derived from the 40 MHz Reference Oscillator, using WWV instead of a frequency counter. *Place the radio in AM mode, and wait until WWV is transmitting an unmodulated carrier. Enable the calibrator and carefully adjust L1001 for exact zero beat with WWV. This method requires that WWV be of comparable signal strength with the calibrator. As such, it may be necessary to select the proper time of day as well as frequency for your area to achieve the desired results.* Inductor L1001 adjustment is performed on the PBT/Reference Board which is accessible by removing the top cover.

DC OPERATION

The R-7A comes equipped to operate on standard 110-120 volts AC with the resulting high heat output from the power supply. A 2-pin receptacle on the rear panel provides up to .25 amps at 13.8 volts DC for powering external devices when the receiver itself is operated from the AC line. This receptacle, when mated with the appropriate adaptor (Drake part #3291052 for less than $5, or equivalent available from Universal Radio), can then be used to bring power into the receiver from an external DC source. This could include operating on a DXpedition with a deep cycle marine battery or from an AC converter for fixed operation.

The power requirement is stated as 3 amps at 11-16 volts DC (13.8 VDC nominal). Ben Hester advises that experimentation with a variable DC power supply should reveal that only about 12.5 volts is actually required for normal operation of the R-7A. If the voltage is reduced too low, the PTO will suddenly cease to operate; if the voltage supplied is more than required, the additional current draw is simply dissipated in undesirable extra heat which can contribute to instability of the PTO.

It is highly recommended that you obtain a 12 volt DC power supply from an electronics supplier and use it to power not only the R-7A but also any other solid state 12 VDC equipment in the shack. The benefits include appreciably less heat (barely warm on the cover of the R-7), potentially improved stability and avoidance of power surges when the gear is turned on. This can contribute to prolonged equipment life and, in some cases, quieter operation. One approach is to purchase an MFJ Model 1116 Deluxe Multiple DC Power 6-Outlet Box, wire it to the AC power supply, provide individual DC plugs for the R-7A and other equipment and plug them into the outlet box, making sure to observe correct polarity. *I also run a Kenwood R-5000 in this manner and the result is much cooler and quieter receiver operation. (JW)*

The wiring for DC operation of the R-7A combined with the RV75 is tricky and interested readers are invited to send a SASE to either of the authors for two variations on this modification.

THE RV75 EXTERNAL VFO

The RV75 is an external VFO introduced by Drake in 1982 for the purpose of making available crystal-controlled frequency stability for all '5' and '7' line transceivers and receivers. The RV75 features the fully synthesized VFO from Drake's professional model R4245 receiver, provision for variable tuning rates, two fixed frequencies, a dial lock, and an RIT control for very fine vernier tuning. The key feature of the RV75 is the frequency stability it provides to the

Figure 3: Front Panel Close-up of RV75 Remote VFO

R-7A. *Mated with the RV75, my own R-7 drifts only 10-15 Hertz during the first half-hour from a cold start, thus essentially resolving the annoying PTO drift problem (typically 100+ Hz) inherent to the R-7A, especially during the first hour or two of operation from a cold start. (JW)*

Figure 3 shows the front panel operating controls of Jon William's RV75. Note that R4245 knobs have been substituted for the Function and RIT controls.

The free-turning, flywheel-weighted main tuning knob tunes the RV75 in 10 Hz increments. The Variable Rate Tuning Oscillator (VRTO) tunes as slowly as 2 Hz per revolution to as much as 25-30 kHz, depending on the rate of rotation of the knob. Two push buttons for fixed frequency 'A' or 'B' allow access to two previously selected external frequencies such as for WWV or a favorite station. The dial lock (similar to that on the Japan Radio NRD-515) permits use of the receiver passband tuning and notch filter controls while preventing an unintended change of frequency if the main tuning dial is accidentally jarred. Finally, the RIT will tune within a range as fine as 500 Hz and will also change the R-7 frequency readout (to the nearest 100 Hz) in all detection modes.

Since the RV75 connects to the R-7A with an 8-pin Jones plug, an accessory called the RV75/R7 Model 1544 Adaptor is necessary. This consists basically of an anodized metal box (3" X 2" X 1" thick) which plugs into the R-7 with a 12-pin plug. In 1982, the RV75 sold for $250 and the 1544 adaptor was a further $30.

Today, because the RV75 is scarce and in high demand, it is very difficult to find and sells in the used market for between $350 and $400. When considering a purchase, one should ensure that it includes the Model 1544 adaptor box so that it will work with the R-7A. The adaptor is no longer available from Drake so the only alternative would be to build one by hand.

I do not use my R-7A without the RV75, even dragging it along when the R-7A goes on a DXpedition. The combination of the aforementioned features together with its great stability transform the already outstanding R-7A into a superb DX receiver. The performance at least equals, if not exceeds, that of the Drake R4245. The R4245 may not be as stable as the RV75 because the receiver VFO is located near the heat-generating power supply, whereas the RV75 provides complete heat isolation for the VFO of the R-7A receiver. (JW)

SHERWOOD OUTBOARD ACCESSORIES

In 1982, Sherwood Engineering introduced its Model SE-3 phase-locked AM product detector. This $300 unit was fed by the 50 kHz 3rd IF output of the R-7A. It was intended to improve the receiver's synchro-phase AM detection by perfectly matching (phase-locking) the carrier of the receiver BFO with the transmitted carrier of a desired signal. The intended effect was improved low distortion ECSS reception with reduced variability from the effects of selective fading. Another benefit was that the receiver PBT and notch filter facilities could still be used to shape the audio before it was processed by the SE-3's superior audio output circuitry. The limiting factor, however, was that the SE-3 would lose lock with the transmitted signal carrier if the receiver drifted by more than about 25 Hz, thus necessitating periodic retuning.

By 1983, Sherwood had introduced another outboard device to deal specifically with the instability problem of the R-7A, thereby enhancing its performance potential with the SE-3. The Model SE-4 was a $150 external stabilizer which interacted with the RIT circuit to compensate for drift of both the analog PTO and the synthesizer reference oscillator. To that extent it could be regarded as a lower-cost alternative to the RV75 external VFO.

We have no personal experience with either the SE-3 or the SE-4. The features and performance of the SE-3 were outlined by Gene Pearson in *Proceedings 1989.* (Pearson, 1989) We also refer to Larry Magne's discussion and review article titled 'Shortwave's Best Fidelity Receiving System...For a Price' in the *1984 WRTH.* He reports: *In our tests, the system worked well, even with an elder R-7 having an unusually wandering PTO. After an initial warmup of sixty seconds, the R-7A, aided by the SE-4, maintained lock with the SE-3 at all times.* (Magne, 1984)

We would concur with Magne's conclusion that the SE-3 would probably be of greater interest to SWL's seeking improved audio fidelity for program listening. The SE-4, however, would seem to be a useful alternative to the RV75 for stabilizing the R-7A. Either accessory, combined with appropriate IF filters and the RIT tuning rate modification, ought to make for highly effective DXing in the preferred ECSS mode.

R4245 KNOB SUBSTITUTIONS

The standard concentric knobs for the RIT/PBT and AF/RF gain functions on the R-7A are small and made of cheap plastic. They are rather uncomfortable to use because of the deep knurls on their outer surface, while the prominent position indicators protrude too much and have an awkward feel. In his review article in the *1982 WRTH*, Larry Magne cites this shortcoming. (Magne, 1982) Rainer Lichte made the same observation in his 1985 review in *Radio Receiver -- Chance or Choice*. (Lichte, 1985)

Both reviewers suggest substitution of the larger and more substantial metal knobs with finer knurls, used on the R4245 receiver. Two sets of part #345-0452B (knob bottoms) and part #345-0452T (knob tops) can still be ordered from Drake at a cost of $2.89 per knob. For a more consistent front panel "look", substitution of the other four knobs (excluding bandswitch and main tuning) can be made if desired. For these, order four of the R4245 part #345-0504 which the company can still supply too at a cost of $2.51 each. Unfortunately, the knobs Drake provides now are apparently plastic replicas of the original metal knobs and they do not have any white line down the knurling "groove" as on the original knobs. Guy Atkins has installed these replacement knobs on his R-7. Although plastic, the knobs still have a quality appearance. He suggests that for easier visual positioning of the antenna and selectivity switches, filling of the appropriate knurled groove with white paint is in order.

Figure 4: R-7A paired with RV75

Figure 4 shows Jon Williams' R-7A and RV75 at the desktop operating position. Jon has substituted R4245 knobs on both units.

Non-metric Allen wrenches are required for installation of the replacement knobs. Guy also cautions that *for the concentric knob sets, the tightening of the outer knobs is very "fiddly". You have to be careful to not overtighten the set screws or else the inner knob will turn in concert with the outer one! If this happens, just keep backing off slightly on the torque of the outer knob until they operate properly.*

The substitution of even the plastic 4245 knobs is definitely recommended as they have a much better "feel" and make use of the controls much easier, especially during extended operating sessions with the R-7A. The larger 4245 pointer knob is also recommended for the RIT control on the RV75.

EXTERNAL SPEAKER PROVISIONS

The R-7A comes equipped with a small, internal side-firing speaker which is inconvenient for many installations and certainly doesn't do justice to the audio capabilities of the receiver. When the R-7 was first released in 1979, it was offered with the option of either a small, newly-designed matching MS-7 speaker ($36 in 1979; $49 by 1982) or the larger MS-4 external speaker for $33. The MS-4 was designed for and carried over from the earlier '4' line receivers, and is valued by many DXers for its sound qualities in the voice frequency range. Either the MS-4 or just about any other quality 3.2 or 4 ohm speaker rated at 2.5 watts or more will provide far crisper and cleaner audio than the poorly designed MS-7. The MS-4 is often available through the Ham Trader Yellow Sheets or at hamfests for about $25. A 1/4 inch phone jack for connection of an external speaker is provided on the rear panel. The internal speaker is muted if an external speaker is connected.

Esthetically, I think the "unmatched" MS-4 looks quite fine placed beside the R-7A. Personally, however, I prefer to use the large, 12" X 10.5" Hammarlund (model S-200, I believe) 3.2 ohm speaker with both the Drake R-7 and the newer R8, as well as with my other hollow state gear having low impedance speaker outputs. If it cannot be found from the usual sources, this speaker is available from Associated Radio in Overland Park, Kansas for a rather pricey $40 but it does provide rich, full-bodied audio response. (DC)

HEADPHONE OUTPUT

Many owners are probably not aware that the output impedance for the front panel, 1/4 inch headphone jack is a rather unusual 220 ohms. Low impedance phones can be used without any problem. With 600 ohm phones such as the popular Japan Radio ST-3, a higher volume control setting is required in the absence of any form of impedance matching. The headphone outlet is always 'hot', regardless of whether the internal or an external speaker is switched in or out.

FRONT PANEL LIGHTING MODIFICATION

For some DXers, the blue lighting on the analog dial and S-meter may be too bright for extended nighttime operation. Unlike a number of more recent receivers, the R-7A does not provide a switch for dimming the pilot lights.

The suggested solution is to order a second set of the blue plastic sheets which fit in front of the panel lights. Drake can still supply the dial insert (part #446-4000) at a cost of only .30 cents, while the S-meter insert (part #446-4001) costs $1. Install the additional set of sheets between the dial window and the original blue sheets. The resulting effect is a deeper blue and more subdued dial lighting.

Every R-7A owner would be well-advised to buy a spare set of the plastic sheets while they are still available. The background pilot lights tend to cause the blue tint to "wash out" over the years. A replacement set of sheets will come in handy to help keep your receiver looking like new.

CONCLUSION

We hope this paper will serve to augment our readers' appreciation of the R-7A and for some of the ways in which its already outstanding performance capabilities can be exploited, and even improved. Certainly it lacks present-day conveniences like memories and scanning capabilities that are important to some hobbyists. But as a "pure performance" alternative at a fraction of its original cost ten years ago, we love it.

The Drake R-7A was, **and perhaps still is**, the *piece de resistance* among other fine DXing receivers.

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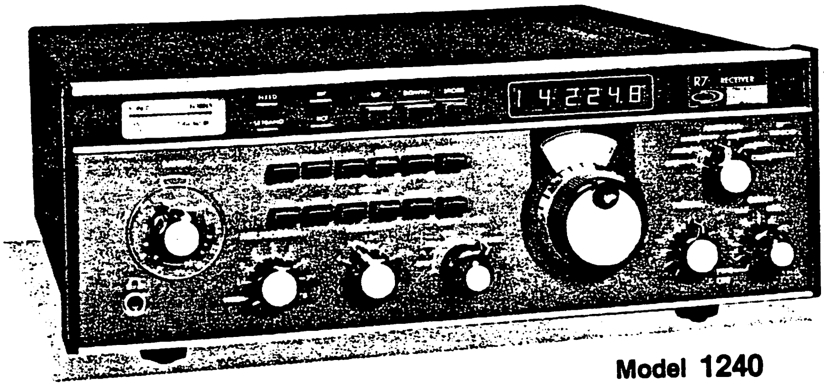
COMPARING SPECIFICATIONS: R-7/R-7A, R8 AND NRD-535D

R-7/A Comparisons	DRAKE R-7/A	DRAKE R8	JRC NRD-535D
$US Price	$700-850 (used)	$980 (new)	$1689 (new)
Antenna Inputs	3 @ 50 ohms (splitter)	2 @ 50 / 500 ohms	2 @ 50 / 600 ohms
Sensitivity AM	< 4 uV .01-1.5 MHz < 1.2 uV 1.8-30 MHz	< 3 uV .1-1.8 MHz < .8 uV 1.8-30 MHz	16 dBu .5-1.6 MHz 6 dBu 1.6-30 MHz
SSB	< 1 uV .01-1.8 MHz < .2 uV 1.8-30 MHz	<1 uV .1-1.8 MHz <.25 uV 1.8-30 MHz	6 dBu .5-1.6 MHz -10 dBu 1.6-30 MHz
Selectivity (kHz @ -6dB)	8-pole Crystal B/W's: 6, 4, 3, 2.3, 1.8 kHz (MW+SWBC DX config)	L/C Bandwidths: 6, 4, 2.3, 1.8, .5 kHz	* Ceramic: 5.5 kHz * Mechanical: 2 kHz Crystal: 1 kHz * + Variable BWC
Shape Factors (@ -60dB)	1.8:1 @ 3 / 2.3 kHz Others: 2:1	1.9:1 at 2.3 kHz Other-Voice: 2.1:1 kHz	2.5:1 Ceramic 3:1 Crystal/Mech
Ultimate Selectivity	> 100 dB	> 95 dB	?
Passband Tuning	+/- 3Hz or more (AM & SSB/ECSS)	+/- 3 kHz or more (AM & SSB/ECSS)	+/- 1 kHz (AM & SSB)
Dynamic Range (1.8-30 MHz)	99 dB @ 100 kHz 95 dB (preamp on)	> 90 dB @ 20 kHz	106 dB @ 300 Hz
3rd Order Intercept Point (1.8-30 MHz)	+ 20 dBm (preamp on) + 10 dBm (preamp on)	> +5 dBm @ 20 kHz > -20 dBm @ 5 kHz	?
Image/IF Rejection	> 80 dB	> 80 dB (1.8-30 MHz) > 60 dB (.1-1.8 MHz)	> 70 dB (1.6-30 MHz)
Notch	IF: 40 dB (AM & SSB/ECSS)	AF: 40 dB (AM & SSB/ECSS)	IF: 40 dB (SSB only)
Stability	< 100 Hz	< +/- 10 ppm	< +/- 2 ppm
Synchronous AM	No (Synchro-phase)	Yes	Yes
VFO's	1	2	1
Memories	No (11 preset + 8 Aux 500 kHz Ranges)	100 (non-tunable)	200 (tunable)
AGC Provisions	Fast/Med/Slow/Off	Fast/Slow/Off	Fast/Slow/Off
Min. Tuning Steps / Freq Display	Analog+RIT / 100 Hz (also 150 MHz Counter)	10 Hz Digital / 10 Hz	1 Hz Digital / 10 Hz
Noise Blanker	Fixed Width	Wide / Narrow	Wide / Narrow
DC Operation	Yes	Yes	Yes
Clock / Timer	No / No	Dual 24 hr / Yes	24 hr / Yes
Audio / Record	2.5W @ 4 ohms / Yes	2.5W @ 4 ohms / Yes	1W @ 4 ohms / Yes
RS-232C Interface	No	Yes	Yes

DRAKE
7-Line Family



Model 1240

R7

Synthesized General Coverage Receiver

Full general coverage reception, 0-30 MHz, with no gaps or range crystals required.

Continuous tuning all the way from vlf thru hf. Superb state-of-the-art performance on a-m, ssb, RTTY, and cw—and it transceives with Drake TR7.

- **100% solid state broadband design,** fully synthesized with a permeability tuned oscillator (PTO) for smooth, continous tuning.
- **Covers the complete range 0 to 30 MHz** with no gaps in frequency coverage. Both digital and analog frequency readout.
- **Special front-end circuitry** employing the high level double balanced mixer and 48 MHz "up-converted" 1st i-f for superior general coverage, image rejection and strong signal handling performance.
- **Complete front-end bandpass filters** are included that operate from hf thru vlf. External vlf preselectors are not required.
- **10 dB pushbutton-controlled broadband preamp** can be activated on all ranges above 1.5 MHz. Low noise design.
- **Various optional selectivity filters** for cw, RTTY and a-m are switch-selected from the front panel. Ssb filter standard.
- **Special new low distortion "synchro-phase" a-m detector** provides superior international shortwave broadcast reception. This new technique permits 3 kHz a-m sideband response with the use of a 4 kHz filter for better interference rejection.
- **Tunable i-f notch filter** effectively reduces heterodyne interference from nearby stations.
- **The famous Drake full electronic passband tuning system** is employed, permitting the passband position to be adjusted for any selectivity filter. This is a great aid in interference rejection.
- **Three agc time constants** plus "Off" are switch-selected from the front panel.
- **Complete transceive/separate functions** when used with the Drake TR7 transceiver are included, along with separate R7 R.I.T. control.
- **Special multi-function antenna selector/50 ohm splitter** is switch-selected from the front panel, and provides simultaneous dual receive with the TR7. This makes possible the reception of two different frequencies at the same time. Main and alternate antennas and vhf/uhf converters may also be selected with this switching network.
- **The digital readout** of the R7 may be used as a 150 MHz counter, and is switched from the front panel. Access thru rear panel connector.
- **The built-in power supply** operates from 100, 120, 200, 240 V-ac, 50/60 Hz, or nominal 13.8 V-dc.
- **The R7 includes a built-in speaker,** or an external Drake MS7 speaker may be used.
- **Built-in 25 kHz calibrator** for calibration of analog dial.
- **Low level audio output** for tape recorder.
- **Up to eight crystal controlled fixed channels** can be selected. (With Drake Aux7 installed.)
- **Optional Drake NB7A Noise Blanker** available. Provides true impulse type noise blanking performance.

R7

Accessories available

Model 1531	Drake MS7 Speaker
Model 7021	Drake SL-300 Cw Filter, 300 Hz
Model 7022	Drake SL-500 Cw Filter, 500 Hz
Model 7023	Drake SL-1800 Ssb/RTTY Filter, 1800 Hz
Model 7024	Drake SL-6000 A-m Filter, 6.0 kHz
Model 7026	Drake SL-4000 A-m Filter. 4.0 kHz
Model 1532	Drake NB7A Noise Blanker
Model 1536	Drake Aux7 Range Program/Fixed-Frequency Board
Model 1548	Drake R7/TR7 Interface Cable Kit
Model 385-0005	Drake R7 Service/Schematic Book
Model 3506	Drake RP700 Receiver Protector
Model 1230	Drake LA7 Line Amplifier

R7 SPECIFICATIONS

Frequency Coverage, continuous tuning 0.01 to 30.0 MHz

Plus any eight additional 500 kHz segments between 0 and 30 MHz when programmed into Aux7 Board.

Crystal Controlled Fixed Frequencies: Up to eight crystal-controlled fixed frequencies within the 0-30 MHz range with Aux7 Accessory Board. Proper 500 kHz range for desired fixed frequency is also programmed into Aux7.

Frequency Stability: Less than 1 kHz first hour. Less than 150 Hz per hour after 1 hour warm up. Less than 100 Hz for ± 10% line voltage change.

Digital Readout Accuracy: (DR-7 installed) 15 PPM ± 100 Hz

Analog Dial Accuracy: Better than ±1 kHz when calibrated to nearest calibrator marker.

Modes of Operation: Ssb, cw, RTTY, SSTV, a-m.

Sensitivity (ssb): 1.8-30 MHz Less than .20μV for 10dB (S+N)/N with preamp on (typically .15μV) (Noise floor typically −134 dBm) Less than .50μV for 10 dB (S+N)/N without preamp (typically .30μV) (Noise floor typically −128dBm). .01-1.5MHz Less than 1.0μV for 10 dB (S+N)/N

Sensitivity (a-m): 1.8-30MHz Less than 1.2μV for 10dB (S+N)/N @ 30% modulation, preamp on. Less than 2.0μV for 10 dB (S+N)/N @ 30% modulation, preamp off. .01-1.5 MHz Less than 4.0μV for 10 dB (S+N)/N @ 30% modulation.

Selectivity (2.3 kHz filter supplied): 2.3 kHz at −6 dB, 4.4 kHz at −60 dB (1.8:1) shape factor. Optional 300 Hz, 500 Hz, 1800 Hz, 4 kHz, and 6 kHz filters are available as follows:

Accessory Crystal Filters

SL-300 cw filter: 300 Hz @ 6 dB, 700 Hz @ 60 dB
SL-500 cw, RTTY Filter: 500 Hz @ 6 dB, 1100 Hz @ 60 dB
SL-1800 ssb/RTTY Filter: 1800 Hz @ 6 dB, 3600 Hz @ 60 dB
SL-4000 a-m Filter: 4 kHz @ 6 dB, 8 kHz @ 60 dB
SL-6000 a-m Filter: 6 kHz @ 6 dB, 12 kHz @ 60 dB

Ultimate Selectivity: Greater than 100 dB

Intermodulation:

Two-tone dynamic range: 99 dB * Third order intercept point: +20 dBm	1.8-30 MHz preamp off
Two-tone dynamic range: 95 dB * Third order intercept point: +10 dBm	1.8-30 MHz preamp on

Blocking: >145 dB above noise floor

** (at tone spacings of 100 kHz and greater)*

I-f and Image Rejection: Greater than 80 dB (48.05 MHz 1st i-f) (5.645 MHz 2nd i-f) (50 kHz 3rd i-f)

Agc Performance; Less than 4 dB audio output variation for 100 dB input signal change above agc threshold. Agc threshold is typical .8μV with preamp off and .25μV with preamp on.

Attack time: 1 millisecond. Three selectable release times: Slow—2 seconds; Med—400 m sec; Fast—75 m sec. Also, "Off" position is provided.

Antenna Input Impedance: Nominal 50 ohms

Audio Output: 2.5 watts with less than 10% T.H.D. into nominal 4 ohm load.

Power Requirements: 100/120/200/240 V-ac ±10%, 50/60 Hz, 60 watts or 11.0 to 16.0 V-dc (13.8 V-dc nominal), 3 amps

External Counter Mode (DR-7 installed): Readout: to 100 Hz. Accuracy: 15 PPM ±100 Hz. Maximum input frequency: 150 MHz. Input level range: 50 mV to 2 V rms.

Dimensions/Weight:

Depth—13.0 in (33.0 cm) excluding knobs and connectors.
Width— 13.6 in (34.6 cm)
Height— 4.6 in (11.6 cm) excluding feet
Weight— 18.4 lbs (8.34 kg)

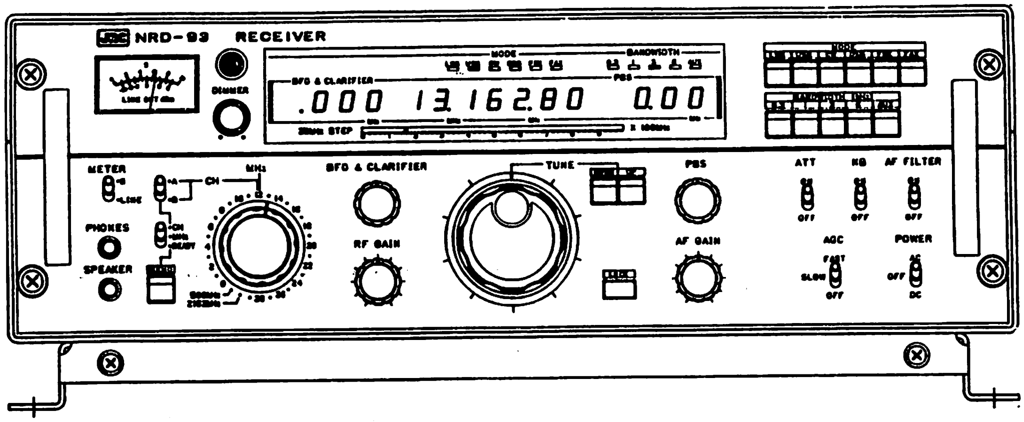
Specifications, availability and prices subject to change without notice or obligation.

R. L. DRAKE COMPANY DRAKE

540 Richard St. Miamisburg. Ohio 45342. USA
Phone: (513) 866-2421 • Telex: 288-017

JAPAN RADIO COMPANY NRD-93 COMMERCIAL/MARINE RECEIVER

Mark Seiden



INTRODUCTION

Like Sir Gawaine searching for the Holy Grail, serious DX'ers search for the perfect radio. While I don't know whether Sir Gawaine ever found the Holy Grail, I do know that I have not found the perfect radio. That's because it doesn't exist. Any electrical or mechanical device is a series of compromises. Technology, design limitations, intended use, intended market, and most importantly, cost, govern every device that we use in our daily lives. Just as no one has designed the perfect writing instrument, no one has designed the perfect radio. But, since this is not the best of all possible worlds, we must make use of what is available, and evaluate things in a relative sense. That's what I attempt to do with this review. While I could easily come up with a wish list for the ultimate receiver, no doubt your wish list would be slightly different. In this particular case, when the new radio bug bit, I wanted to supplement my listening post with the best of whatever was available. After much soul searching and one or two conversations with a very understanding wife, I decided that for my purposes, the best available receiver on the market, regardless of price, was the Japan Radio Company NRD-93. What follows is the result of operating this radio on an almost daily basis for ten months. While I did have a IBS White Paper on the NRD-93 before I took the plunge, I did not have the benefit of an in depth user review. My non-technical observations are meant to assist those contemplating the purchase of a high end receiver, and to provide information to readers interested in the NRD-93 receiver.

DESCRIPTION

The NRD-93 is a solid state, double conversion, superheterodyne receiver, which was designed for both commercial and marine use. It was meant for serious monitoring by government and commercial agencies, as well as for employment at coastal stations and on board ship. The retail price, with accessories, is $8,605.

The radio is physically large, measuring (with the NDH-93 scanning unit mounted on top of it) 19" wide, 9 5/8" tall, and 11 7/8" deep. The depth is important. It is no deeper than an R-7, or an NRD-535D. This means that when you place the radio on top of your desk, you still have plenty of room for writing, looking at your atlas, and consulting reference books. By comparison, the Watkins-Johnson HF 1000 is almost 21" deep and leaves little space for anything else on the average desk.

The radio is no lightweight. The receiver itself, with cabinet, weighs 33 pounds. The NDH-93 scanning unit adds another 12 pounds, for a total of 45. While this is about half the weight of an R-390A, it should pose no extraordinary problems.

Both the receiver and scanning unit are designed for a 19" rack mount. There is an optional cabinet for both the receiver and scanning unit, which is a necessity unless the units are rack mounted. The cabinets are built like an M1A1 Abrams tank. They are solid, heavy gauge riveted steel, and are obviously, like the '93 itself, designed to withstand hard use. They are eminently stackable. Both the receiver and scanning unit cabinets come with metal feet, which are designed to be bolted to an operating desk in a ship's radio room. The previous owner of my NRD-93 replaced those metal feet with large rubber ones. Unless the NRD-93 is actually intended for marine use, the rubber feet make a lot more sense. Presently, an Icom R-7100 and KIWA MAP unit sit atop my radio and scanning unit, and I have no doubt that in time, other accessories will find their way on top of the '93 as well.

The face of the radio is finished in a light gray. The cabinet is a light aquamarine green. While this is very untraditional and takes a bit of getting used to, it is actually quite attractive. The paint finish on the cabinet surpasses the finest automotive finish that one might expect on a ultra-expensive luxury car. In short, it is superb.

The radio, which has no internal speaker, comes with a non-matching outboard speaker, designated as the NVA-92. The face of the speaker cabinet is a traditional dark military gray. The remaining cabinet is the matching aquamarine green. On my particular radio, the previous owner had Electronic Equipment Bank in Vienna, Virginia, replace the actual speaker in the NVA-92 cabinet with a high quality 4 Ohm unit, which gives excellent audio fidelity. At the same time, EEB added a grounded three-prong plug to the radio's power supply, and installed a JRC 1.8 kHz filter (CFL-218A) in the auxiliary bandwidth position. The second I.F. is 455 kHz, which allows the installation of accessory filters by JRC, KIWA, or Collins.

OPERATING CONTROLS AND TUNING

Those of you who are familiar with the NRD-515 will be right at home with the NRD-93. The tuning scheme on both radios is almost identical. In fact, as can be seen from the line drawing, the control layout for both radios is very similar as well. Like the NRD-515, the '93 uses a megahertz knob to select any one megahertz range between 0 and 30. There is a main tuning dial that covers 10 kHz per revolution, and to the right of that there are up/down slewing buttons that change frequency at several hundred kHz per second. The digital readout on the main display contains orange LED characters that are approximately 1/2" high. The main display reads to the .01 definition level, and the display is electrically quiet.

To the left of the main display is a BFO & clarifier which functions as an RIT control. The LED readout here is also 1/2" in height, though it is in green and most important, reads out to the .001 level. In other words, it is possible to visually fine tune the radio down to the individual hertz.

To the right of the main display is another green 3-digit 1/2" digital LED that gives a readout of the passband offset in 10-hertz increments. To the right of the display is a series of push buttons for mode (LSB, USB, CW, DSB, FSK, and FAX), with a series of five push buttons for IF filter selection below that. The radio comes with four high quality filters with excellent shape factors (1:1.5 per Magne's White Paper) as standard. The wide filter is 6 kHz at -6 dB. The intermediate is 2.5 kHz, the narrow is 1.0 kHz, and the CW filter is .3 kHz.

Additionally, there is a -20 Db attenuator, a noise blanker, a dial lock, manual controls for RF and AF gain, as well as a knob to control the brightness of the readouts. There is also an extremely useful audio filter that works well at reducing noise, a switch to select either the fast, slow, or off modes for the AGC, and several other switches relating to both the memory function and the S meter. The S meter does not read in the standard S units that we are accustomed to. Rather, the top part of the scale is calibrated from 0 to 10, and the bottom part of the scale is calibrated in line out dBm. Either reading is user selectable from the front panel. Strangely enough, the S meter is not lighted. At first I thought that this would be annoying, but it has not proved to be so.

There are two 1/4" front panel jacks. One is for a set of 600 Ohm headphones, and the other is for the 4 Ohm speaker. Inserting the headphone into the headphone jack does not mute the speaker audio circuit. If you want to mute the speaker audio circuit, you must physically disconnect the speaker jack from the front panel, which is easy enough to do.

All JRC radio controls have excellent feel. Those of you who have had the pleasure of operating an NRD-535 or an NRD-515 appreciate their quality. The NRD-93 is even better. The control feel, especially the main tuning knob, is superb. The buttons and switches work like you would imagine the controls of the space shuttle to feel, and every aspect of the radio has a solid, built-to-last touch about it that one would expect in an expensive commercial receiver.

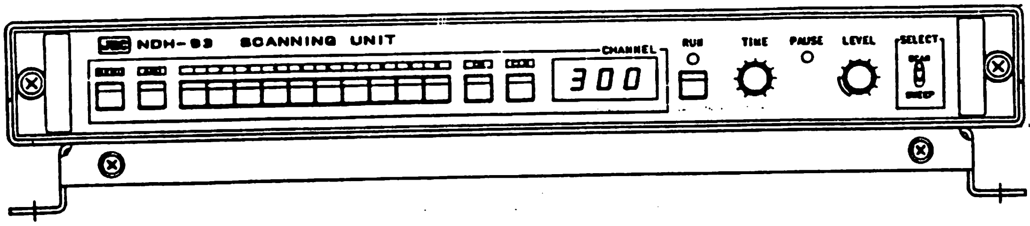
One of the big problems with the NRD-515 was the touchy RIT. It is very difficult to zero beat the '515 because of that. Not to worry in the NRD-93. The '93's RIT not only reads out to the individual hertz, but also can be easily tuned to select that individual hertz, even when wearing gloves. I'm sure they designed it that way.

With the exception of the megahertz selection knob (which also serves double duty as a 60-channel memory), all of the controls on the radio are single function-single purpose. There are no concentric knobs, and all of the controls, knobs and switches are pleasingly large.

Those of you who haven't fallen asleep by now have probably noted that I haven't mentioned a keypad. That's because the NRD-93 doesn't have one. This is real shame, because each frequency must either be tuned in individually, or selected from one of the 360 available memory channels. While the radio is not as cumbersome to tune as is, say, a

Drake R-7, it is certainly not as quick to tune as one of the push button radios of the '90's. Often, I find myself punching up frequencies on my NRD-535D to see what's available. When I find something I really want to listen to, I then tune it in on the NRD-93. For slow bandscanning, however, such as a trip across 60 meters, the '93 is a real joy.

According to the date on the chassis, my radio was built in 1983. Despite that, JRC designers had apparently decided not to employ the user friendly tuning technology that they used in the earlier '515 and later '525 and '535 hobby radios. What this means is that assuming that you were listening to WWV on 15 megahertz, in AM (DSB), when you select upper side band, the radio fails to select the offset automatically and detunes itself to 14.998.50 MHz. Conversely, going from AM to LSB, causes the frequency to shift to 15.001.50 MHz. This, like the Icom R-71A, requires that you retune the radio every time you change mode. Since the radio is such a pleasure to tune, this is really no big deal; but it is a bit of yestertech.



MEMORIES

While the NRD-93 may be a little antique in its tuning scheme, it more than makes up for this in the memory department. The NDH-93 scanner, which came with my radio, has a retail of $1,125 all by itself. It's almost worth it. The NDH-93 scanning unit has a provision for 300 memories. Unlike the 96-channel scanning unit that was an option with the '515, all 300 of the NDH-93's memories are tunable. All of the memories can be selected individually, or they can be selected by bank. If you prefer to scan memories number 1, 6, 89, 95, 252, and 298, while excluding all the others, that can be done as well. You can also sweep frequencies once you set upper and lower frequency parameters and mode.

The scan delay is selectable, as is the level. The level selection is both important and interesting. If you enjoy monitoring the BBC, you can program a number of BBC frequencies into the memory, setting what you consider an acceptable signal level with the level control. When the level for the frequency that you are listening to drops below what you have predesignated as being acceptable, the radio will then search out the next strongest BBC frequency and lock on to it. This is a neat feature.

Since I spend a lot of time monitoring pirates, I merely program 10 to 12 of the most active pirate frequencies, set the level fairly low, and allow the radio to scan among the preselected frequencies until somebody comes on the air. This saves a lot of knob twiddling when pirate activity is slow on any given night. It's also possible to program in your favorite PNG or Indo frequencies and rapidly scan through them each morning. Someone who spends a lot of time DXing on the broadcast band can also program in all of the available frequencies between 530 kHz and 1700 kHz, rapidly switching from frequency to frequency much faster than they could with a keypad setup.

There are also 60 available memory positions accessible through the MHz knob, which are also tunable. While these 60 memories cannot be automatically scanned, they can be manually selected, and are very handy as well. All in all, 360 readily accessible, tunable memories minimize the inconvenience of the lack of a keypad, though they do not eliminate it.

HOW DOES IT WORK?

How a radio really performs is actually the proof of the pudding. In this case, the pudding is very good. Simply put, the NRD-93 is the best radio I have ever used. Besides being generally user friendly and a pleasure to operate, it performs better than anything that I've ever sat in front of before. At the time of its purchase, I placed it alongside a full house NRD-535D (with an extra filter, a high stability oscillator, and all of the upgrades available), a beautiful example of a Drake R-7 (with a full set of filters), a Gilfer modified NRD-515 (with the NDH-518 scanning unit), and an EEB modified Icom R-71A (HPXF option, plus a few extra goodies). It simply outshone all of them.

First of all, the receiver is dead quiet. Its noise floor is -141 dBm, and its local oscillator noise is rated by Sherwood at 133 dBc. There is no other solid state receiver that I am aware of that approaches these figures. In addition to being extremely sensitive and selective, the radio is blessed with a Tracking Preselector that is rated by Sherwood as an "A+." The only other Tracking Preselector that he rates as an A+ is that of the Collins R-390A. This means that the radio's front end is pretty much bullet proof. The audio is also superb. If you close your eyes, you would think you were listening to a hollow state radio. This is more obvious when the '93 is used with a good speaker. The favorite speaker in my shack is a Drake MS-4. The combination of the NRD-93, and the MS-4 produces sound that actually makes program listening and speaker DXing a pleasure. The AGC action is also excellent, with no over-shoot and very appropriate time constants.

When the extremely low noise floor, excellent audio quality, superb front end, very appropriate AGC, precise tuning, and professional quality filters are combined in one package, the result is the ability, on occasion, to dig usable, even enjoyable audio out of the mud that is unlistenable on a lesser radio. While there were no actual signals that were heard on the NRD-93 that could not be detected on the other radios, the difference was that at times, the '93 provided usable audio on marginal signals when the other radios couldn't. In all fairness, this didn't happen all the time. Once in a while, the NRD 535D or R-7 would hear something better than the '93 did. But those occasions were rare. And under no circumstances did the R-71A or '515 perform as well as the '93. They weren't in the same league when DXing tough signals.

BCB DX'ers will be interested to know that there was no perceived degradation of performance between 530 kHz and 1700 kHz on the '93 either.

As is expected in a radio of this price class and quality, the stability of the set is rock solid. Simply turn it on, select a frequency, and walk away. I verified it will still be at that exact same frequency, within one or two hertz, days later.

BUILD QUALITY

The NRD-93 was designed to last a long time, and in difficult environments. In addition to standard AC, the radio can be used with 24 volt ships' current. Each control was obviously designed to withstand many thousands of operating cycles. The radio utilizes JRC's concept of slide-in, printed circuit boards attaching to a motherboard. The printed circuit boards are thick, of very high quality, and are all waterproof. The filters, according to my ear, are symmetrical. The cabinet, as stated, is designed for heavy duty use. The components are all well shielded. The radio runs extremely cool, which means that the high quality components should last a long time. A comprehensive operator's manual comes with the set, and the receiver can be repaired by a knowledgeable technician, the Japan Radio Company, or Raytheon, who services JRC equipment in the United States. Strangely, however, there is no service manual available for the '93 from JRC. The NRD-93 is ruggedly designed and built with components selected for long life and operational stability. It is built to exacting standards with workmanship and parts far above the quality of the best hobby receivers.

DEFICIENCIES

All, however, is not perfect. It never is. There are a few flies in the ointment, though they are small flies. First, the radio has no notch filter (neither did the NRD-515). This has not proved to be a problem for me since I use the radio with the superb JPS NIR-10 digital audio filter. The NIR-10 is an excellent accessory for the '93. In addition to being the most advanced audio filter on today's market, it is a het killer par excellence. Merely activate the automatic notch filter on the NIR-10, and it searches out hets, even multiple ones, and kills them without a trace. Therefore, I do not consider the absence of a notch filter a serious drawback.

Since this radio was designed for commercial rather than hobby use, ease of use for commercial radiotelephone operators was paramount. As a result, if you are listening to a signal in the AM (DSB) mode using the 6 kHz filter, when you select USB or LSB, the radio automatically selects the 2.5 kHz filter. If you want to listen to USB or LSB with a 6 kHz filter, you must then manually reselect that filter after you've changed mode. It doesn't work the other way, though. In other words, if you're listening in the USB mode with a 2.5 kHz filter, going up to AM (DSB), doesn't automatically invoke the 6 kHz filter. All it takes to select a filter is a simple button push. You don't have to carousel through all the filters to get the one you want.

The passband tuning on the radio is excellent. It really does help manipulate a signal in order to obtain the maximum usable audio. However, the width of the passband shift varies according to the filter that is selected. In the 6 kHz filter position, there is a range of + or - 2.0 kHzs of passband shift available. With the 2.5 kHz filter, the range is + or - 1.2 kHz. All of these ranges are appropriate for ECSS tuning with the various filters that come installed in the radio, with the exception of the auxiliary position. Unfortunately, JRC decided that a very narrow CW filter was what the operator was likely to install in that slot, as they only allow 80 hertz of passband shift while in the auxiliary position. This very much reduces the usefulness of that position.

For the type of monitoring that I do, I wanted to retain the 1.8 kHz filter, but increase the available range of the passband shift while using that filter. At the same time, I wanted a narrow AM/wide SSB filter, which the radio lacked. Russ Scotka, DX South Florida's resident electronic genius, performed some minor surgery on the radio that allowed these two aims to be achieved. First, Russ removed the 1.0 kHz JRC filter and inserted the 1.8 filter in its place. This is a drop-in fit. Next, he installed one of KIWA's premium 3.5 kHz filters in the auxiliary slot. This was not a drop-in fit. In order to get the KIWA filter to work, Russ had to fabricate a pair of 4.7 Mh chokes to match the filter to the IF board. Once this was accomplished, the 1.8 kHz filter had 500 hertz of passband shift, and there was an additional level of selectivity between the 2.5 kHz and 6.0 kHz choices that were previously available. The 3.5 kHz filter in the auxiliary slot only has 80 hertz of passband shift, but since it is primarily used for narrow AM and wide SSB use, this has not proved to be a serious problem. Still, I would like to increase the range of the passband shift in the auxiliary position, though to my knowledge, there is no way to correct that deficiency. If anybody out there has discovered a way, please let me know.

The NRD-93 does not have a synchronous detector the way the '535-D and the Drake R-8 do. The technology wasn't available when the radio was designed. Since the audio on the radio is excellent, even a mismatch of one or two hertz can be detected. This makes tuning to within one or two hertz critical when monitoring in the ECSS mode with a wide filter. Once this is done, the audio remains excellent. I had the good fortune of obtaining a KIWA MAP unit on the used market not too long after I obtained the NRD-93 (see Guy Atkins' excellent review of the MAP in *Proceedings 1989*. Russ Scotka installed direct pickups in both the NRD 535D and the NRD-93. The MAP unit allows instant audio comparisons between receiver audio and MAP-processed audio. There was a tremendous improvement noted when the 535D's signal was fed through the MAP unit. However, the audio on the NRD-93 was so good that often the unprocessed audio from the NRD-93 actually sounded better than the same NRD-93 signal fed through the MAP unit! In other words, while the radio does not have a synchronous detector, it is not really missed. What actually is missed is the presence of an effective noise blanker. The NRD-93 does have a noise blanker switch on the front panel. To say that it is less than effective would be an understatement. I have yet to be able to determine one single situation where activation of the '93's noise blanker had any effect on the audio. That is why an external noise blanker, with a notch filter, such as the JPS NIR-10 or the JPS NTR-1, is a required accessory with this radio.

OTHERS CONSIDERED

There are, of course, other radios available in the same price range as an NRD-93. The Icom R-9000 is one example. I thought about the R-9000, and decided against it. I was concerned about reports from George Zeller and Larry Magne that indicated the AM filters were inappropriate and that the radio ran very hot. Since I was interested in a radio that only tuned through the shortwave spectrum, I thought that my money would be best directed in some other area.

To complicate things further, Watkins-Johnson announced their HF-1000 at the same time I learned that there was a mint NRD-93 available for purchase. This was a real dilemma. I spent many hours on the phone talking with radio enthusiasts about this quandary, particularly Dallas Lankford, who is one of the most knowledgeable radio enthusiasts in the United States when it comes to receiver design. Dallas, from a review of the specifications, told me that the NRD-93 was really the only way to go. He pointed out that the local oscillator phase noise on the HF-1000 was worse than the local oscillator phase noise in the NRD-525! He also pointed out to me that the HF-1000 did not have a Tracking Preselector, and further, that its digital filters seemed to "blow out" at about 75 dB. He also questioned whether a radio with a rated AM sensitivity of 1.58 microvolts (which was the spec on the HF-1000) was really suitable for DX work.

On my own, I discovered that not only did the HF-1000 have an unusually deep footprint, but there was no cabinet available for it, and most important, the passband shift apparently only worked in the CW mode. Fifty-six digital filters or not, I simply could not imagine operating a radio without a passband shift operable in all modes. All of this, coupled with the fact that while HF-1000's were more or less readily available, my chance of finding another mint NRD-93 was rather rare, convinced me to opt for the '93. I'm not sorry that I did.

In all fairness to Watkins-Johnson, I have not had the opportunity to test their radio. Dallas' comments were made from a review of published specifications and not a hands-on test. I wrote their project engineer and asked for a test sample about ten months ago, hoping that I could compare it side by side with the '93. Unfortunately, the radio never came.

THE BOTTOM LINE

Okay, the reader may ask -- what does it cost? Well, that depends whether you buy new or used. Personally, I have had excellent luck over the years purchasing used radios. This one was no exception. When I decided that I wanted a used '93, I mentioned it to Gilfer Shortwave's Paul Lannuier, then employed at JRC's New York office. A few months later, Paul called me and told me that one of his customers was selling one. He said the customer was a reputable collector, who was very fussy about his gear. I telephoned the seller and got a description of the radio, which he rated as "9.8 out of 10." He also gave me a few references as to people he had previously done business with. I checked the references out, and he did, in fact, appear to be perfectly reputable. We agreed on a price of $3,750, with shipping to be paid by me and packing to be paid by him. I took a big gulp and mailed him a cashier's check. Within about three days, my radio arrived. It was, in fact, "a 9.8 out of 10." Perhaps it was even a little better than it had been described. In any event, I was very happy with the purchase and would not hesitate to do it over again the same way.

According to list prices, the radio, with scanning unit and cabinet, has a retail price of approximately $8,600. Unfortunately, the radio is no longer in production. There is, however, an inventory of radios available through the Japan Radio Corporation which have not yet been sold. It is my understanding that these radios are available for $7,000, with scanning unit, speaker and cabinet, new.

As far as the used market goes, I would expect to pay somewhere between $3,000 and $4,000 for the radio, depending upon condition and accessories. A radio without the scanning unit, cabinet and speaker might sell for as low as $3,000. A mint set with all the goodies might go for as much as $4,000. There are not many NRD-93's in hobbyists' hands around (it has been estimated there are only about 50 in the United States), and they do command something of a premium when you find one. In my opinion, they're worth it. Paul Lannuier is extremely knowledgeable about JRC radios, and seems to be a clearinghouse for information relating to Japan Radio Company equipment. He would be a good place to start your search for a '93.

SUMMARY

There is no magic radio out there that will allow you to hear PNG's in Kansas City at high noon. As far as I am concerned, once you get into the R-7/NRD-535D/NRD-515/NRD-525/Drake R-8 class, any improvements from there on will be in small increments. There is a ceiling, somewhere around $1,500 or $1,600, where the law of diminishing returns kicks into high gear. But to the serious radio enthusiast, small increments can be very important. If you are one of those people and you especially enjoy operating a very high quality piece of equipment, then you should consider the NRD-93. While there is some competition with the radio by others in the same price range, it really is in a class by itself. And, if you are interested in buying one, mine isn't for sale.

THE LOWE EUROPA HF225

Chuck Mitchell, WB9NWF

FORWARD

The Europa version of the HF-225 is another enticing offering in the expanding Lowe product line. The Europa produces excellent, non-fatiguing audio and performs admirably as a transportable DX receiver. Elegant, rugged design blended with engaging audio reproduction are typical attributes of British audio electronics. U.K. Hi-Fi manufacturers such as Linn, Naim and Creek produce some of the world's finest domestic stereo systems. These products satisfy the music enthusiast by reproducing the source signal with accuracy and integrity. It is my opinion that Lowe Electronics, Ltd. brings this philosophy to the communications receiver market. It is evident once again that Lowe's design staff know what makes a great receiver.

THE EUROPA DIFFERENCE

The success of the HF-225 provoked many European DXers to request modifications for this dependable receiver. The DX Club of Finland petitioned Lowe with a number of mods to fit their specific needs. Lowe agreed to modify the club's receivers and dubbed the project "Finlandia", in honor of their northern DX customers. Although circuit changes were costly, the transformed receiver satisfied the members. Lowe was recognized for their enhanced 225 when the "Finlandia" was proclaimed as "Best DX Receiver of the Year" by the European DX Council in 1992. The receivers tested included the JRC NRD-535 and the ICOM R-72E. It's impressive to discover a company that listens and responds to constructive advice.

News of this special edition receiver spread around Europe. Because of the extensive interest, Lowe decided to produce a special edition of the HF-225 called the "Europa". The "Finlandia" project was then terminated.

The Europa modifications are not available as a retrofit kit for a standard HF-225. The HF-225 is modified to the Europa spec during production. So what are the differences between the HF-225 and the HF-225E?

The IF filter bank has been changed to improve filter performance over the original HF-225. A new 3.3 kHz filter replaces the original 10 kHz that was previously determined by the 45 MHz first IF filters. The control software was rewritten to reflect the new filter configuration.

Bandwidth Matrix Chart: A Comparison

HF-225					HF-225E				
FILTER SWITCH POSITION	1st IF FILTER 45 MHz	SECOND IF FILTER 455 kHz			FILTER SWITCH POSITION	1st IF FILTER 45 MHz	SECOND IF FILTER 455 kHz		
		Filter 1	Filter 2	Filter 3			Filter 1	Filter 2	Filter 3
10	15	Thru	Thru	10	7	15	7	Thru	7
7	15	7	Thru	10	4.5	15	7	4.5	7
4	15	7	4	10	3.5	15	3.5	4.5	7
2.2	15	2.2	4	10	2.2	15	2.2	4.5	7

Figure 1. Filter Matrix

All filter chokes have been replaced by high quality magnetically shielded chokes in order to prevent unwanted leakage across the new filters. Filter decoupling capacitors are bypassed by new chip capacitors. Additionally, filter selection diodes are replaced by low capacitance switching diodes. According to Lowe, the effect of these changes is a noticeable improvement in skirt selectivity and residual noise performance of the receiver.

The only cosmetic difference is the word "Europa" that appears under the volume and tone controls on the front panel. Lowe includes the synchronous detection/FM option and the keypad with every Europa receiver.

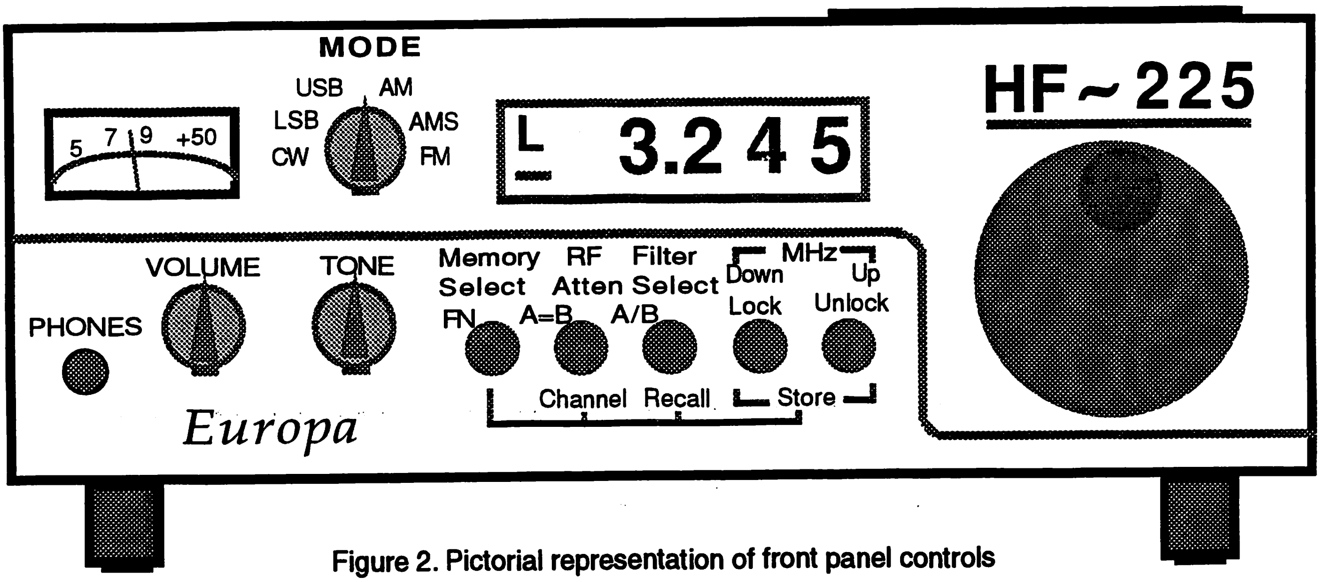


Figure 2. Pictorial representation of front panel controls

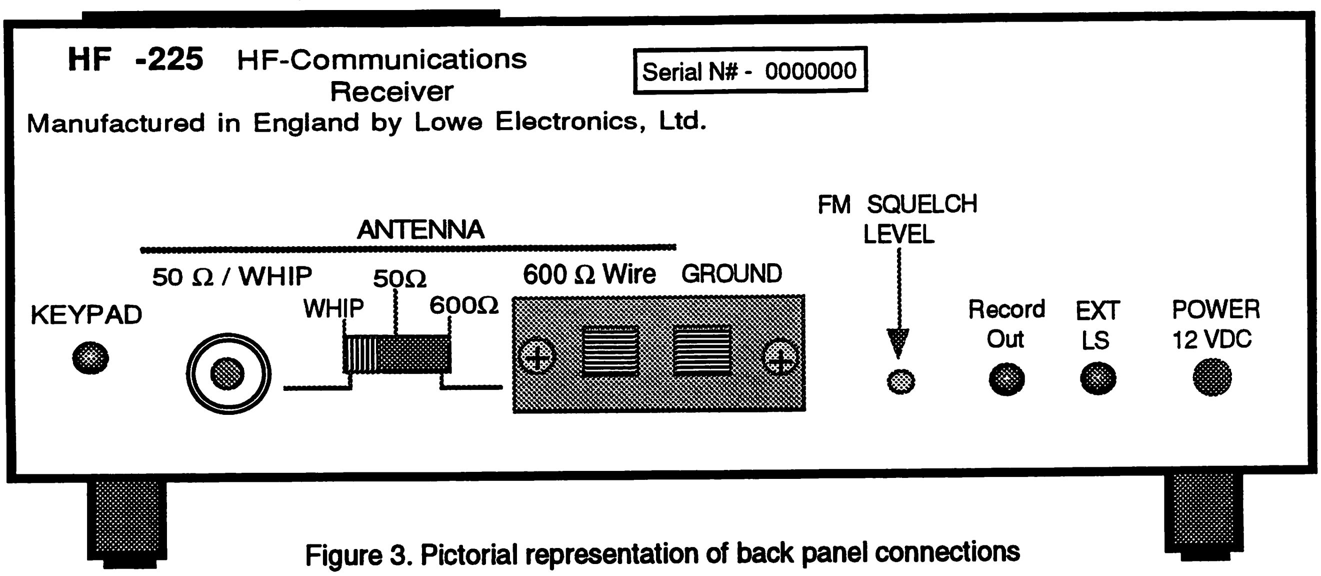


Figure 3. Pictorial representation of back panel connections

PERFORMANCE

Although the Europa can be configured as a self contained portable, this review will focus on the receiver as a transportable DXpedition rig. I would like note that as a portable, with whip antenna and preamp option included, it is more sensitive than a Grundig Satellite 500 or Sony 7600 with equal antenna lengths. The three receivers were tested in one of the worst situations possible: a noisy apartment complex sitting on the ground floor. It was impressive to copy a weak WWV at 2:00 PM local time on 5.0 MHz ONLY on the Europa. I do recommend the addition of the preamp/whip at the time of order. It's an inexpensive option but does require soldering to the base board if installed by the owner. Sensitivity is on par with all desktop receivers that I used for this review. These rigs included the NRD-515, Drake R7a/ RV-75, Drake R7 and a Kenwood R-5000.

A DXpedition is a good judge of a receiver's character. This is especially valid when one has the luxury of comparing it to familiar receivers on the same antenna system. A trip to the field proved helpful in evaluating the HF-225E against the Drake R7 and a modified Kenwood R-5000. Dynamic range, selectivity and audio reproduction were the three areas most noticeably different in the test. The Lowe exceeded all receivers tested in terms of audio reproduc-

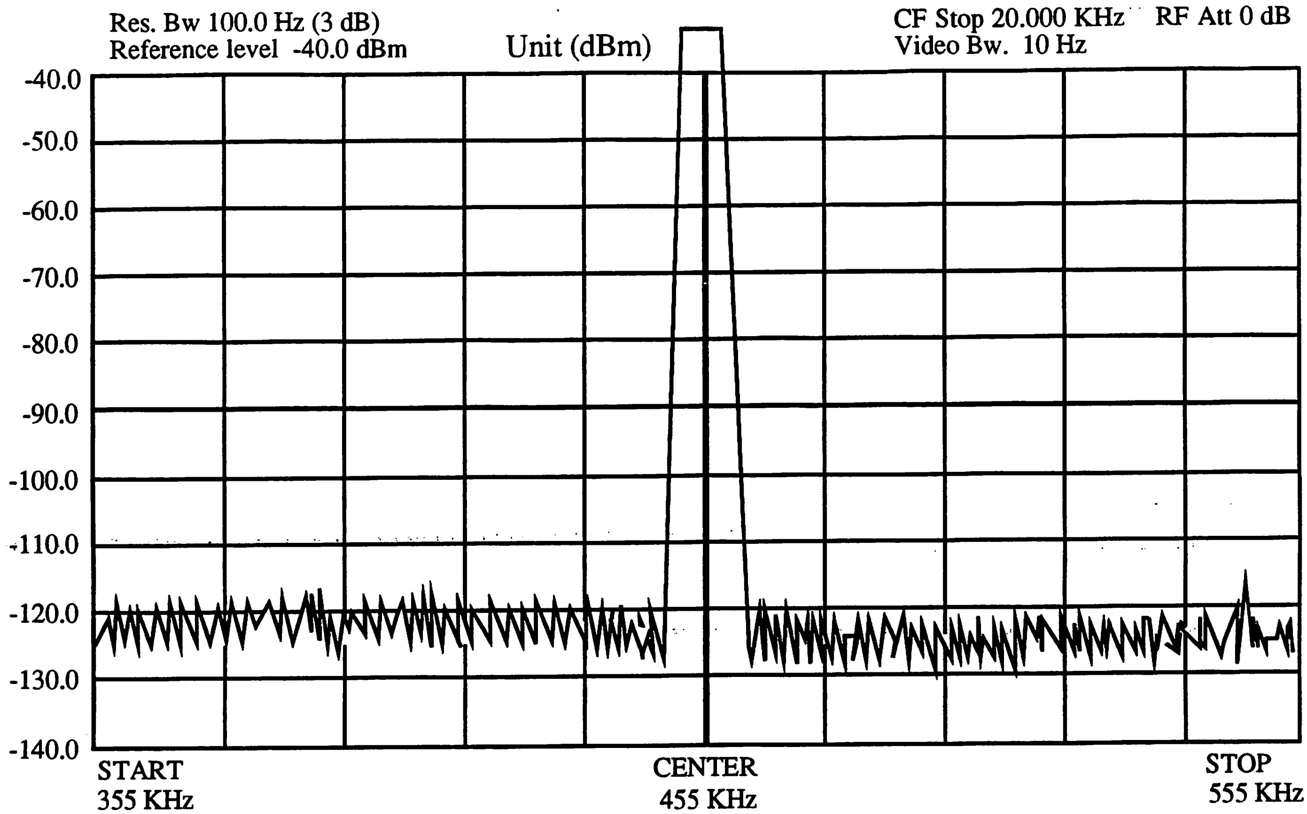


Figure 4. Wide sweep from 40 to 140 dB at 10 dB/div. of the receiver IF filter strip (AGC disabled) in the 4.5 kHz filter position. Note figure 1 bandwidth chart.

tion. The two field test receivers were connected to an I.C.E., Ltd. active antenna splitter. The splitter provides unity gain from one antenna to a maximum of four receivers. It could be connected to any of five Beverages ranging from 200' to 1000' in length. The most startling difference was between the R-5000 and Europa, in terms of dynamic range and selectivity. All three receivers were tuned to 650 kHz where RCN of Colombia was coming through with a respectable S7 signal and good audio. Squawk and splatter from adjacent channel stateside stations was annoying on the R-5000 in any mode, regardless of filter selection. The Lowe and Drake R7 came shining through with a clean, splatterless signal! I was able to open the HF-225E to the 3.5 kHz position and still enjoy a clean signal. Keep in mind the R-5000 was equipped with crystal filters of 1.8, 2.2, 4.0 and 6.0 kHz. This situation was common as the evening progressed. John Thorpe, one of the Lowe engineers, attributes this difference to gain distribution in the IF stages . Modern solid state rigs often use a fairly high amount of gain in the early IF stages. The HF-225E minimizes gain in the first IF to improve dynamic range and selectivity. I was beginning to understand why the EDXC choose the Europa as a premier DX receiver.

Front end overload characteristics appeared equal to the other test receivers. Radio Enga on 2410 kHz surprised us with audio that morning and I expected to hear some MW leaking through the Europa's front end at sunrise. Although connected to some very long antennas, the Europa never overloaded. Despite intense levels from local MW stations, I have never had an overload problem on the Europa on any or at the test shack in Indianapolis, Indiana. The longwave band has been free of bleed through from strong local MW stations. Antennas have included half wave dipoles, full wave Delta Loops, random long wires and 1000' Beverages. Tuners or preselectors have not been required so far. The Europa's front panel 20dB attenuator has never been needed on MW or SW.

Navigating around the shortwave spectrum is a breeze with the supplied keypad. I prefer the Europa's mouse style keypad over the front panel type found on many contemporary communications receivers. Direct frequency entry is possible on frequencies above 3000 kHz. Below 3000 kHz, the user must punch the "#" key after each entry. Selection of memory channels one through ten is available at the keypad.

The rig's dual VFOs and 30 memories proved sufficient for storing potential targets and rapid checks on parallel stations. A controls lock is switched from the front panel.

The DXer may connect two antennas to the Europa. A 50ê or 600ê input can be selected with a back panel slide switch. Spring loaded push connectors are provided for the high impedance antenna input and ground connections. A standard SO-239 coaxial connector is furnished for the low impedance antenna.

The receiver has extended front legs that can rotate out from the base. This provides the perfect angle for viewing and tuning.

Currently, there are no computer control applications available for the HF-225/HF-225E. This may appear to be confusing since Lowe offers a software control program for the HF-150 via the keypad jack. Although both radios use the same KPAD-1 keypad, the HF-150 and HF225E microprocessors interpret control commands differently.

Engaging the W-225 amplifier is likely to cause overloading when lengthy external antennas are used. This is not surprising for a simple broad banded whip amplifier. The amp works fine for short wires or the supplied whip.

Mention the word Lowe and most DXers will associate it with outstanding audio quality. The Europa produces some of the sweetest sound you'll ever hear from a shortwave signal. Connect a hearty communications speaker to the 225E and crank up the volume. You'll swear there are tubes under the hood! (The venerable Drake MS-4 speaker is a perfect match for the rig.) One thing I have noticed about Lowe receivers is how involving the listening experience is. Tuning in your favorite Latin American station yields Salsa that's more "caliente" and Bossa Nova that transports you and the girl from Ipanema back to Rio. This little receiver reproduces music in tuneful manner and digs deep in the QRM to retrieve critical voice information. AM audio is good enough that you'll use it in this mode more often than with other rigs.

The tone control is actually a variable high pass/low pass filter. The center position renders flat audio response. Turn it clockwise and low frequencies are attenuated. Counter clockwise positioning will roll off high frequencies. Careful manipulation of the tone control with various filter selections can be most helpful in refining audio from a station in heavy QRM and QRN. One of my favorite combinations is the 3.5 kHz filter position in the AM mode with the tone control adjusted to approximately 3 o'clock. Tuning off to the edge of either sideband yields highly intelligible audio with a medium IF bandwidth.

Audio quality from the record out jack on the back panel is excellent.

IF IT ONLY HAD A...

Competing against heavy weight receivers like the R7 and NRD-515 is not always a winning situation. The obvious shortcomings on the Europa are the lack of readout to .1 kHz, IF notch filter and IF passband tuning. A narrower voice filter of 1.8 kHz would have been a good fifth filter choice. Although the unwanted sideband rejection is excellent when using the 2.2 kHz filter, this is not the case with the 3.5 kHz position. You can ECSS tune with the 3.5, but a medium strength het can bleed through to the opposite sideband. The audio in ECSS narrow is excellent, however.

Datong produces a compact audio filter called the ANF-Automatic Notch Filter. This product is a perfect solution for the missing notch on the Europa. The palm sized filter can be used in "seek and destroy" mode or manual mode to wipe out heterodynes. The ANF preserves the audio quality of the Europa and is virtually transparent when switched in line. It actually improves the audio a little in the narrow mode by reducing hiss when the tone control is in the high pass mode. The ANF easily connects between the receiver's audio out and a speaker/headphones like most audio filters. Low current drain makes it ideal for battery use. The Datong ANF sells for about U.S.$165.00.

Some people have expressed frustration with the absence of selectable sidebands in synchronous mode. I don't feel that this is a major issue for the DX listener. The receiver more than compensates for this fault by it's superior tuning ease in ECSS mode and superb audio quality when using the narrow 2.2 filter. The synchronous detector works competently and is a real treat to the ear when a station is in the clear.

The antenna selector would be more convenient if mounted on the front panel.

POWER ISSUES

The Europa draws approximately 200-350 ma at 12 VDC, depending on the options installed and volume level. Lowe ships a nice regulated power supply with the receiver. The external supply provides a clean, hum free DC source. There is no internal AC supply. For DXpeditions, I use a 12v/12amp sealed lead cell purchased from an astronomy supply store. Lowe has an internal nicad pack option that produces 9.6 VDC from 8 cells that are suspended above the main circuit board. The assembly holds the batteries securely, but does not protect the receiver's mother board from the unlikely event of battery leakage. This makes the Europa a self contained system, but should not be considered ideal for the DXer. A 12-14 VDC supply should be used to insure maximum performance. The first mixer is operates more efficiently on the high side of the voltage range. Fourteen volts is probably ideal, according Lowe. Twelve to fourteen volts will assure maximum dynamic range.

PRICE

At the time of writing, the only Lowe dealer in the U.S. that will import the receiver is the Electronic Equipment Bank of Vienna, Virginia. The stock Europa costs U.S. $899.00 and includes keypad, synch/FM option and power supply. The W-225 whip option sells for U.S. $40.00. You may have to wait a couple months for delivery. The Europa is a good seller and it's frequently on back order.

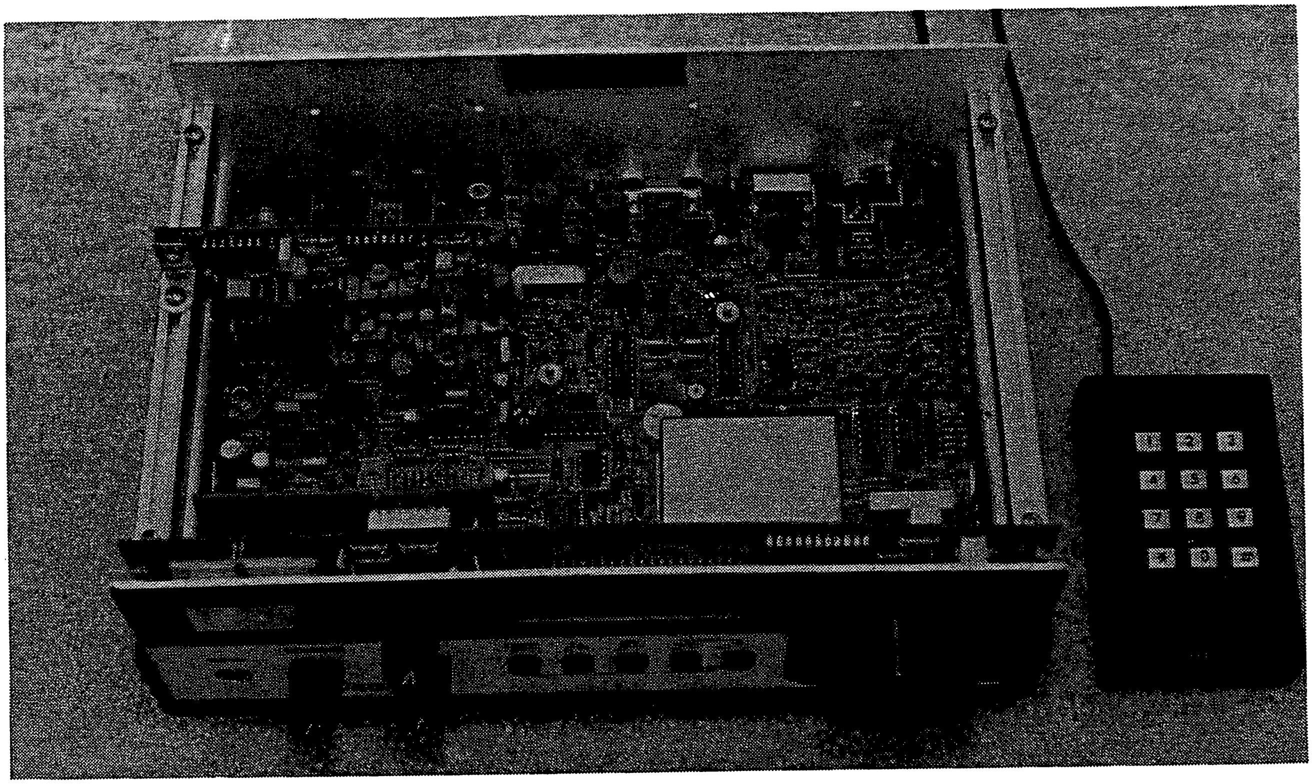


Figure 5. Interior view of the Europa and external keypad. The keypad is standard with Europa model.

CONCLUSIONS

If you are looking for a multitude of bells, whistles and clocks, the Europa can't compare to other similarly priced receivers in the U.S. If you are searching for a great transportable DX receiver, then Europa will satisfy, if not exceed, your expectations. I don't believe you will find a more selective and better sounding receiver in a rugged lightweight package. The quality of design is evident inside and out. This is a well crafted, low maintenance receiver. The controls have a solid and positive feel. There are no wiring harnesses or point to point wiring inside (Note figure 5). Weak signal DX performance is very close to that of formidable desktop rigs like the NRD-515. While the Europa appears subtle on the exterior, it's a dependable DX receiver at heart. The HF-225 "Europa" has been placed on my top ten list of things I would require if stranded on a desert island.

ABBREVIATED SPECIFICATIONS

Dimensions: 253 x 109 x 204 mm (WxHxD, including projections). **Power Requirements:** 10-15 VDC, Quiescent current 200ma, no options, no audio. Typical consumption 250-300 ma. **Weight:** 1.9 kg., 2.6 w/internal battery.

Frequency Coverage: 30 kHz to 30 MHz.

Reception Modes: AM, LSB, USB, CW, Narrow band FM, AM Synchronous.

Display: 5 digit back lit negative LCD (green) readout to 1 kHz. Analogue S-meter calibrated S1-S9, +10dB, +30dB and +50dB.

Tuning: keypad or variable rate tuning knob.

Tuning Rates: CW, SSB, AMS 8 Hz steps at 1.6 kHz per revolution, AM mode 50 Hz steps at 9 kHz per revolution.

Memories: 30 frequency memories selectable with spin dial, memories 1-10 can be selected with keypad, two tunable frequency stores (VFO A/B).

Memory Functions: Store, Recall Preview and Channel, current tuned frequency is saved when receiver is switched off.

IF Filters: 7, 4.5, 3.5 and 2.2 available in AM, AMS, LSB, USB, 12 kHz for FM, 2.2 kHz IF and 200 Hz audio filter (centered at 800 Hz) available for CW.

Receiver Shape Factors: 7 kHz/1.41:1, 4.5 kHz/1.38:1, 3.5 kHz/1.53:1, 2.2 kHz/1.4:1.

Frequency Stability: Less than 30 Hz per hour.

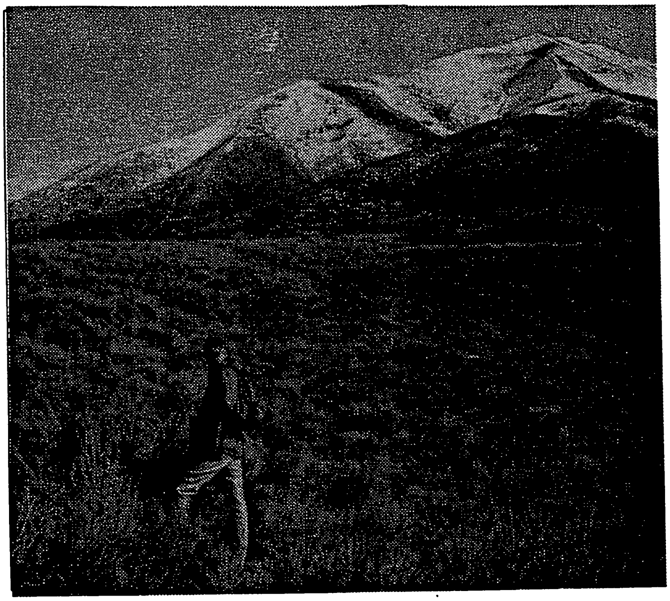
IF Frequencies: 45 MHz/455 kHz.

Dynamic Range: (2.2 kHz) greater than 90dB at 10 kHz from wanted station, 20dB RF attenuator front panel selectable.

Noise Blanker: audio blanking triggered by IF signal level permanently enabled on all modes, blanking period 500 ms.

Audio Outputs: 1/8" jack for record out at 350mV, 1/8" jack for external loudspeaker, 1/4" headphone jack, stereo or mono plugs.

Antenna Inputs: 50 ohms SO-239, 600 ohms wire and earth connections on spring terminals, Hi-Z active input for whip antenna.



Europa

AVAILABLE OPTIONS FOR THE HF225E:

B-225 Internal Battery: User installable inside receiver. The eight cell nicad pack will operate the receiver at 9.6vdc for 8 hours on a full charge. Batteries are charged when the rig is switched off.

C-225 Case: Hard leather case with removable speaker cover and rear panel cut-out for connections.

W-225 Whip Antenna: Small broadband preamp module fitted to main receiver board. Includes telescopic whip antenna that plugs into the 50 ohm SO-239 jack.

Service Manual: A must read!

Figure 6. The Europa provides the author with a desktop quality rig that can be tossed over the shoulder and transported anywhere.

Figure 7. The author's portable DX listening station includes the HF-225E, Datong ANF, Sony Walkman Pro WMD6C cassette recorder and a 12VDC rechargeable battery pack.

COMPARING THE DRAKE R-8 AND THE JRC NRD-535D

John Bryant

Since major new top-of-the-line communications receivers are only introduced one or two times a decade by most manufacturers, it was probably unfortunate for all concerned that the two current king-of-the-hill receivers were introduced almost simultaneously in the spring of 1991. Strangely, no one has ever published an in-depth IN-USE direct comparison of these two fine receivers. This project and article are an attempt to bridge that gap.

The Drake R-8 was a success almost as soon as it entered the market. According to informal comments made by Drake executives, the initial sales volume of the R-8 was much larger than they had anticipated. They planned for the receiver to be a strong contender in the mid-priced ranks of communications receivers and they succeeded beyond their dreams. This success in the North American market was probably due to several factors. The first and foremost was that the R-8 delivers great value for its under $1000 price position; a second factor mentioned by many reviewers and happy owners alike is the sparkling clear audio. Most tube gear aficionados value the R-8 audio as being the most clear, most intelligible and nearest to "tube audio" of any modern digital-dialed receiver. Die-hard tube-type DXers like Jerry Berg (HQ-180) and Pat Martin (SP-600 on MW) bit the bullet and went to solid state as soon as they tried an R-8. The last major factor in the success of the R-8 in the US market has never been discussed in print: it is an American success story. Many senior American DXers have long felt badly about the demise of Hallicrafters, National, and Hammarlund, while many of these same DXers enjoyed the latest miracle box from the Far East as their personal receiver. Thus, more than a few American DXers were overjoyed at the chance to buy the latest hot receiver and simultaneously support one of the last vestiges of the American electronics industry.

It may also be true that the early success of the R-8 was partly due to both developmental and marketing errors on the part of Japanese Radio Company. The NRD-535D was introduced to North America before the variable Bandwidth Control accessory was available. The NRD-535D, like the 525 before it, had very poor AGC action. Also, the truly wonderful synchronous AM detection with selectable sideband was mis-named the "ECSS" control. The latter was probably a foolish marketing strategy that has really confused potential customers. ECSS as the term has developed in the DXing community refers to receiving AM signals in single sideband mode (product detector) exalting the carrier with the receiver's internal BFO.

For all of these reasons and more, the Drake R-8 is a resounding American success story and the NRD-535D languishes in the doldrums of the North American SWBC DX market. In the last two years, "conventional wisdom" around many hobby gatherings has been that the R-8 is simply a better radio than the much more expensive NRD-535D. That opinion is so strongly held is some quarters that I am somewhat reluctant to write an article which dares to differ with that conventional wisdom.

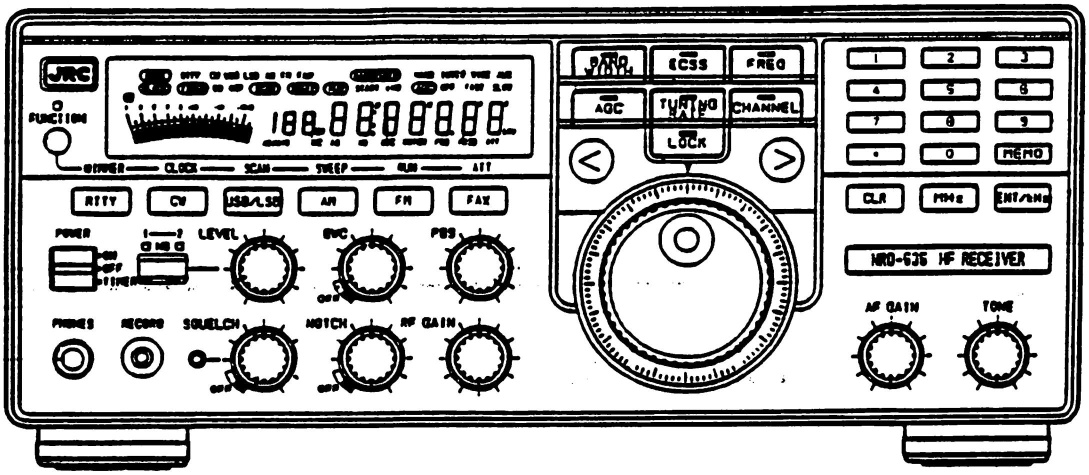
PROVENANCE

I neither own or intend to purchase either of these two fine receivers. Thus, I have neither pride of purchase nor romantic involvement with either one. My own NRD-<u>525</u>, though a flawed design that I'm still angry about, has been modified enough that I find it to be "as much receiver as I need." My NRD-525 review should put to rest any concerns related to positive bias toward JRC on my part. (Refer to "Waste Gunner on a 525," *Proceedings 1988.*) If there is any bias in my view of these receivers, it would be toward the Drake unit.

PROCEDURE

I was able to borrow both an NRD-535D and an R-8 from Bill Bowers for the tests discussed in this article. I used them intensively for ten days in both dawn and evening Tropical Band and MW DXing sessions. I sought out the most difficult or weak signals and attempted to ID and take detailed logs. The antennas used were a variety of Beverages and an active whip (Dymek DA-100). Both receivers were fed signals simultaneously through a low-loss antenna splitter. The handiest test device that I used for this project was a home-brew switchable audio patch cord. This was wired so that both receiver could be plugged into the same 8" low impedance external speaker simultaneously. A DPST switch in the patch cord allowed me to switch instantaneously from one receiver to the other. If the audio gain of the two receivers was carefully matched, and both receivers were carefully tuned to the same signal, flipping the audio switch only changed the quality of the audio coming from the speaker.

In practice, I started with one receiver, optimized reception of the test signal, flipped the audio switch and optimized reception of the same signal with the second receiver. Then it was back and forth with the audio switch, tweaking each receiver as I went. At some point, no further improvements could be made. I then listened for at least 10 minutes to both speech and music, taking notes as I went. This is the fairest kind of non-numerical, in-use DXer's test that I could construct.



INITIAL IMPRESSIONS: ERGONOMICS

JRC NRD-535D

When I began this project, I expected the 535D to be a slightly repackaged 525 with 1990s "jelly bean" curves rather than the crisp 80s look of the 525. I was pretty sure that the 525's well known and serious problems with audio hiss, AGC, selectivity and ergonomics would still be there, albeit in a prettier package. I had heard rumors that the 535D's AGC was awful and I knew from pictures JRC had failed to replace its artificial gas display S-meter with a real electromechanical one.

I was pleasantly surprised by the NRD-535D. The ergonomics are outstanding! In fact, the 535D is easier to operate than any other major receiver that I have ever used. Whether ease of operation is important to you probably depends on your DXing style. Some people are very active at the controls, tweaking for quite a while in different modes and band widths before settling down to listen. Other folks tend to "know" the proper settings and are less active. If you are an active tweaker, the NRD-535D is the radio for you.

Since this is not a review of the 535D, I'll not belabor the ergonomics point. One example will serve: control of mode of reception. If you want AM mode, hit the AM button; if you want SSB, hit USB/LSB button once for USB, hit it again for LSB; if you want to try synchronous detection, hit the "ECSS" button once for synchronous AM locked to the upper sideband, hit again and you are in synchro-AM on the lower side of the signal. To say it another way, it is possible to invoke the mode of choice by hitting ONE button without carouseling through ANY OTHER mode. Absolutely wonderful.

One final point: when special functions like Notch, variable Band Width Control, Noise Blanker, Passband Tuning, etc. are invoked, warning lights appear either on the control itself or the display. The opportunities for operator error are vastly reduced as compared to the 525 or, especially, the R-8.

DRAKE R-8

From a DXer's point of view, the R-8 is an ergonomics nightmare. True, it is possible to "learn" the R-8, but even so, the large amount of carouseling required is time consuming, frustrating and fraught with possible error. So many important functions have to be carouseled or "shift" carouseled (the Notch, for heaven's sake!) that highly active DXing is a button-pushing nightmare. Period. The too narrow spacing between the main tuning knob and the Band Width and Mode buttons has been thoroughly discussed elsewhere; suffice to say that this design flaw has been known to cause even veteran R-8 jockeys to swear and shake their fists in the direction of Ohio.

Before we get angry at the Boyz from Miamisburg, we should look at the ergonomics and budget problem from their point of view. They were designing a general use (listener's) receiver for the upper middle price portion of the market for relatively unsophisticated users. Hence, they used a near minimum number of controls and, originally, configured the software so that the "appropriate" band width was automatically switched in when the operator changed reception mode. Ignoring the frequency keypad buttons, Drake designers allow us to control a complex receiver with only seven buttons and three sets of dual concentric knobs. JRC designers, working with almost twice the parts budget, deployed 7 knobs and 13 buttons to control the same set of functions. In my opinion both groups of designers did an excellent job and achieved their project design goals. The two receivers were designed for different price ranges and different types of users.

We are truly fortunate that Drake designed such an excellent "listener's" radio that it has proven to be a formidable DX machine for a quite reasonable price. *From a DXer's point of view* though, the vote for ease of operation has to fall squarely to the NRD-535D. Bravo JRC!

INITIAL IMPRESSIONS: DXING

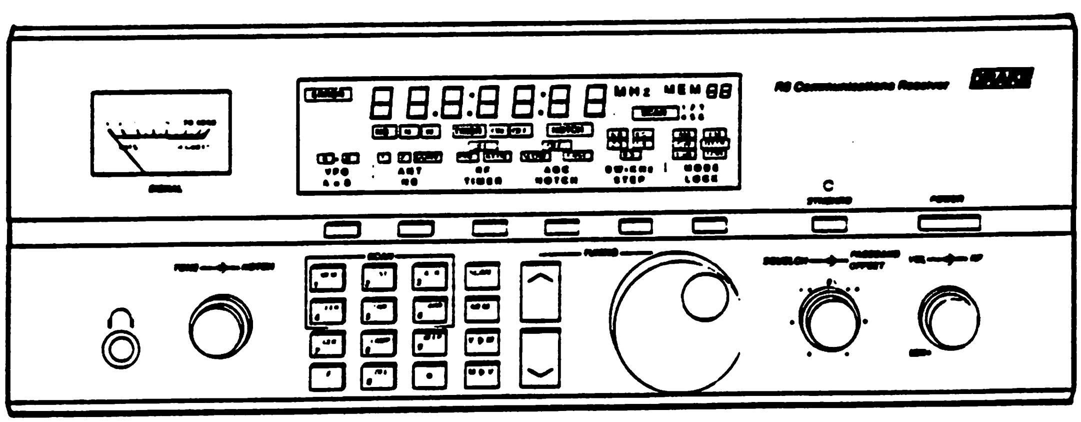
JRC NRD-535D

My initial impressions at SWBC DXing with the 535D were somewhat negative. Although the controls were very easy to use, and selectivity and sensitivity seemed to be very acceptable, the AM audio in the Intermediate IF (2.0 kHz) position was very muffled. The same was also true in "ECSS" synchronous AM with the intermediate filter. True ECSS reception (using USB or LSB product detection for an AM signal) was not really much of an improvement. Trying to DX with the Wide IF filter (6.0 kHz) was impossible, though the audio did seem much clearer..

The 535D's so-called "ECSS" function, actually AM synchronous detection with selectable sideband, is the most effective and easiest to use of any of the synchronous detection systems that I have used. The 535D's synchro AM detector locks on at much lower signal levels than the R-8, holds lock well and works great.

AGC action is very poor, at least from an SWBC DXer's point of view. The attack time in AGC Fast is very aggressive and the release time is EXTREMELY slow in both Fast and Slow AGC settings. Any fast noise blip (a static crash, an arcing light switch in the house, etc.) causes the AGC to reduce the gain to near minimum. It then takes nearly forever to recover. Essentially even a single strong noise will deafen the receiver for over a second!

So, the initial impressions of the NRD 535D are mixed: superb ergonomics, excellent synchro AM detection, extremely poor AGC design and inappropriate IF bandwidths. The latter two doomed the NRD 535D (as initially introduced) as an SWBC DXer's receiver.



DRAKE R-8

This comparison test simply confirmed what the marketplace has shown in recent years: the R-8 is a fine DXer's receiver. The sparkling audio is a real aid in understanding program details and ID's under difficult receiving conditions. The middle three IF filter settings are very useful in DXing (4.0 and 2.3 in AM or 2.3 and 1.8 in ECSS) and ECSS mode is both easy to use and very productive with the R-8.

The R-8's synchronous AM detection was a disappointment. I found it very cranky to use in anything but ideal conditions when trying to detect relatively weak signals; QRM confused it badly and fading of a weak signal could cause it to hunt and grumble. A number of R-8 owner/DXers report similar experiences. Others however, find the R-8 version of synchronous detection quite useful as a DX tool. The difference here may lie in the DXer's personal style and references, or it may lie in variations in manufacturing, or both. In any case, I did not find the R-8's synchronous detection useful while DXing. It's AGC design, along with the rest of the electronic design of the receiver seems superb. The R-8 is a wonderful general use or listener's radio and, almost inadvertently, an excellent DX rig...all for less than $1000. Bravo and well done!

THE REST OF THE STORY

The first NRD 535D I used for a couple of days in 1991, was an early North American unit without the Variable Bandwidth Control. My experience then was just as described above. For the first three days of the 1994 test, I continued to work with the 535D as described. Even though Bill's (the owner's) relatively new 535D came with the Variable Bandwidth, I did not find that much-ballyhooed control of much use. However, the more I used the two receivers during the formal comparison, tweaking controls and flipping back and forth, the better I got at maximizing the performance of the 535D. The synchronous AM, selectable sideband detector is a true wonder! In quiet conditions (necessary because of the awful AGC), reception of tough signals was *better* with the 535D in most cases, except for the blasted muffled audio!

I'm ashamed to admit it, but it took me until the fourth day of intensive DXing to even think of trying DX signals with the 535D in IF Wide selectivity and with the Variable Bandwidth narrowed from 6 to about 4 or 3 kHz. *What a difference!* Suddenly, the much maligned audio of the 535D became *excellent*. It sparkles; it sounds like tube audio; it is even better (yes) than the R-8...Yes! Frankly, I feel like an absolute fool to not have tried this earlier. I can only plead that I have never met a hobbyist who DXed in the WIDE selectivity position. In truth, the Variable Bandwidth function allows you to maximize the relationship between current noise conditions and audio response. Since the high frequency audio elements of speech are essential to understanding, the BWC control is the finest new DXing tool that I have used since ECSS became fashionable 10 years ago.

Frankly, I am shocked that so little (nothing?) has been published in the hobby press about JRC's new Variable Bandwidth Control! It is true that the first NRD-535s sold in the U.S. did not have the BWC cards installed; it is also true that the first version of the BWC card did not work in the AM Wide position. However, the NRD-535D has been configured like the one I tested for at least a couple of years. This Bandwidth Control is *revolutionary*. I'm also shocked that neither JRC nor major dealers have featured this new and unique feature more heavily in their advertising.

The same day that I discovered the Wide Setting/BWC control combination, I performed a five minute modification to the AGC of the 535D, a modification published in several places which recently describes adding one resistor to the IF AMP board to significantly reduce AGC decay time. (The article is reproduced at the end of this discussion). This easy modification (though it is not factory approved and voids the warranty) cured the AGC problems in near miraculous fashion. Now, I find both Fast and Slow AGC settings very useful DX settings.

With the "discovery" of the Wide IF/BWC control combination and the corrected AGC circuit, the 535D became like a new receiver. Almost instantly, the A/B DXing comparisons showed the 535D performing noticeably more effectively than the R-8 in almost every difficult situation.

Since David Clark is known as a receiver guru as well as a legendary DXer with the R-8 and the HQ-180, I gave him a call to see if he knew any R-8 operating strategies that I didn't know. Sure enough, David has discovered that operating R-8's in ECSS/LSB allowed the Passband Tuning to rotate through almost all of the upper sideband as well as the lower one. The same is not true when operating in ESCC/USB! From then on, I always tried the ESCC/LSB setting with Passband control rotated to USB when tweaking the R-8 in the A/B comparisons.

FINAL COMPARISONS:

USABLE SENSITIVITY ("HEAR-ABILITY")

This criteria combines technical sensitivity and audio quality to judge how well an extremely weak DX signal may be heard and understood with a receiver. My best test signals for usable sensitivity were Radio Myanmar (Burma) on 4725 kHz during dawn enhancement and 4712.6 R. Abaroa, Riberalta, Bolivia in the local evening. When I performed these tests, both transmitters were very well modulated but the audio level of each was at or just below the general level of the background noise. On two different days with each signal and over dozens of comparisons, I could hear and understand more of the programming on the 535D. The differences were relatively small but I considered them significant. The best settings for the R-8 were ECSS/LSB rotated to the USB side in 2.3 IF. The best setting for the 535D were Synchro AM, USB, detection in WIDE IF, with the BWC control at about 3 kHz.

USABLE SELECTIVITY

Again, this is my own DXer's criteria. My definition is how well can I hear and understand the AM programming of relatively weak signals under a variety of very crowded and difficult conditions. The NRD 535D proved over and over to be the better receiver under these A/B tests. It outright won about half of these tests and most of the rest were ties. The

R-8 did prove to be superior in a few situations. The control settings varied with conditions of course; with the 535D I tended to end up in synchro AM either USB or LSB with the wide IF setting narrowed various amounts with BWC; with the R-8, I usually ended up in ECSS, using the Passband shift control, the Notch and in either 2.3 or 1.8 kHz IF filters.

ONE IMPORTANT NOTE: It is not possible to operate the notch filter of the NRD-535D while the reception mode is either one of the two "ECSS" AM synchro settings. It is a shame that this is the case; however, I did not find the Notch control very necessary when DXing in AM synchronous mode, so this fault may be trivial to most DXers.

THE BOTTOM LINE

The Drake R-8 retails for about $950 in the U.S. in 1994. The JRC NRD 535D as configured in North America (BWC standard) retails for $1700. From a SWBC DXer's point of view, the NRD 535D with the discussed AGC mod aboard is a better radio. The overall performance advantage DXing AM signals on the Tropical Bands is however, small. Is it worth $750? Now that I have performed these tests, I would have no difficulty whatsoever in answering that question. Buy a 535D!

AGC SPEEDUP MOD FOR THE NRD-535

from Paul Lannuier

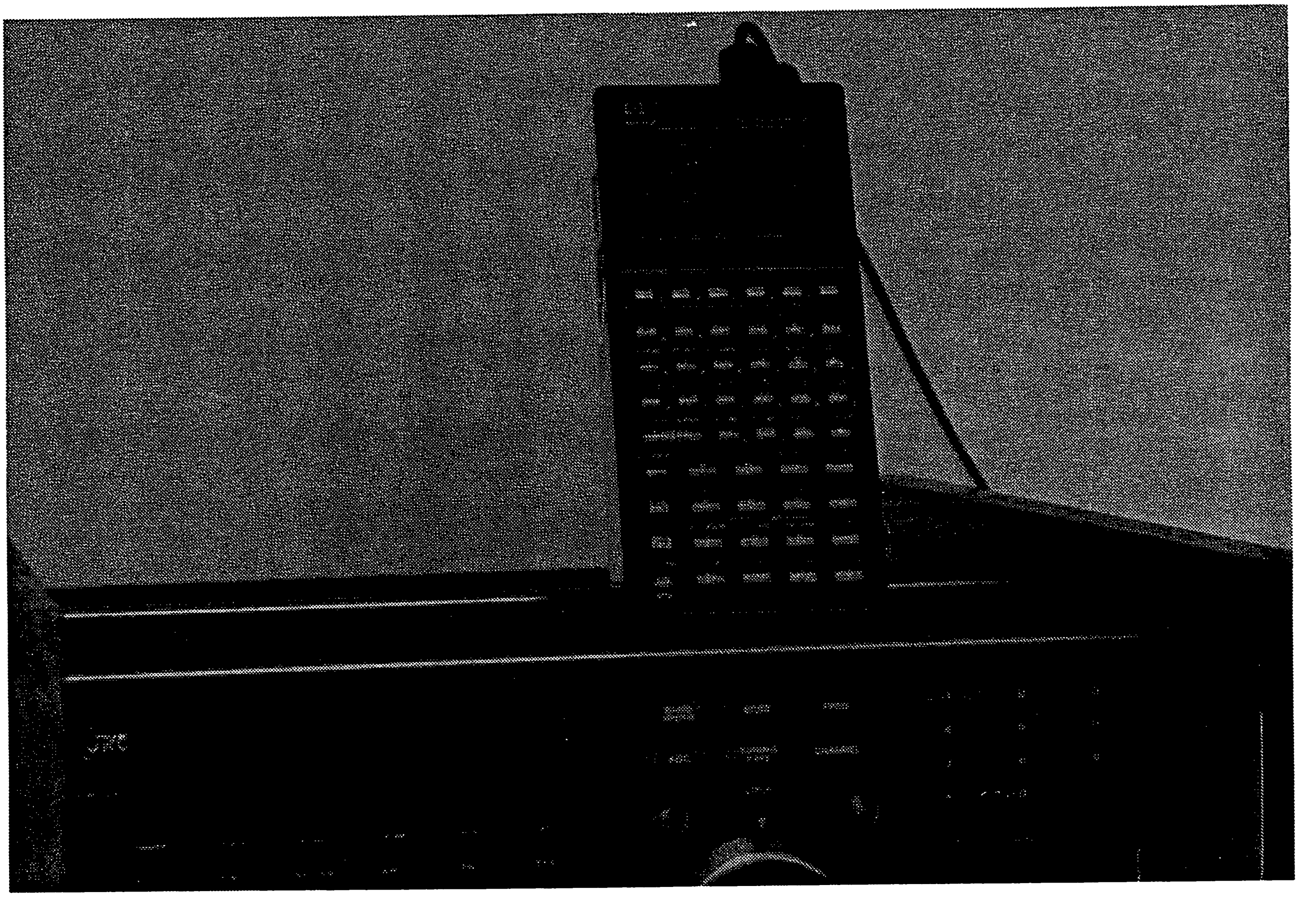
For those who are interested, this mod was developed by Michael Cobuccio (WA1EYP) of Merrimack, NH. He found that adding a 1M ohm resistor between the positive side of C104 and the negative side of C105 of the IF Amp circuit board (CAE-227A) will speed up both Fast and Slow AGC *settings. Variation in resistance will effect the decay speed, e.g. lower resistance = faster decay.* (Several DXers have found 470 K ohm resistors work best. - JHB).

NOW FOR THE CAVEAT: This mod was not approved by the factory, so do it at your own risk. That said, there doesn't seem to be much risk in tacking a resistor to the (underside of this) *board. Removal is easy if the effect seems undesirable to the user.*

peripheral equipment

RECEIVER CONTROL USING A HANDHELD CALCULATOR

Tom Napolitano



FORWARD AND BACKGROUND

As much as the venerable hollow state receivers of times past are still up to the demands of today's DX listening, when it comes time to purchase a modern receiver, it is difficult to ignore the common characteristic of all high end receivers today; all of them can be modified to add computer control in some form. The computer software market has responded with many fine programs for most computers, and allow us to take advantage of the new receivers. Two kinds of programs exist. Some are designed to provide remote control of virtually every receiver function from the console of the computer. Others are more like data base managers that keep files of frequencies, times and receiver settings and are extensions of the receiver's internal memories. Along with this function, the computer can be is used to log stations and frequencies for future reference.

TRADITIONAL COMPUTER CONTROL

Some DXers are unimpressed with the mating digital microprocessors to analog radio receivers. I'm not here to sell the concept of computer control but will say that everyone I know who has tried it has grown to appreciate what computers can do for their listening and DXing pleasure. An alternative to computer use is to use one of the modern handheld calculators such as the HP48 series from Hewlett-Packard as the receiver controller. It is less expensive and avoids many problems with computers.

There are advantages to using a full size personal computer; larger disk drives for unlimited storage space, high speed operation and dozens of software systems. They are available everywhere new and used. On the other hand, a common complaint with personal computers is that the internal clocks that drive them are also radio frequency generators. Video monitors also generate interference from their internal circuits and from interface cables. Shielding, rf chokes and just plain good design helps to varying degrees, but the most effective rf eliminator is still the power switch. The HP48 on the other hand can sit directly on top of the NRD535 without interfering with the receiver.

Full size computers work well as long as a source of AC mains current is available. Even the latest crop of portables are not able to run for the duration of a weekend DXpedition without need of a recharge. The three AAA cells of the HP48 last for weeks of heavy use. It is the perfect computer for settling into a log cabin or tent. If only they could make it work on butane.

TYPICAL USAGE

It is possible for the HP48 to control any of the current top-of-the-line receivers. Indeed, it could conceivably be used to control any intelligent device having a low speed serial data interface. What follows is based on my experience mating it to the NRD525/535. The HP48 connected to the RS232 port of the NRD525/535, behaves much as a hand held remote control of consumer appliance fame, albeit with a cable attached. There are 49 buttons on the calculator, each of which may be redefined to perform any single function or to execute any previously entered program. The HP48 series of calculators is capable of addressing enough memory to maintain a large data base of frequencies, as well as the time schedules for all the stations of interest. Larger data files can be maintained and manipulated on a standard personal computer or even a minicomputer or mainframe computer. Hence, you should never run out of storage space. Data can be transferred between the HP48 and any computer that supports the HP48 data transfer protocol, which includes almost every computer ever made.

PROGRAMING EXAMPLE

The Hewlett-Packard line of Hand held calculators, which began in 1972 with the HP35 scientific calculator, uses logic known as RPL or Reverse Polish LISP. The HP48gx is fully programmable in RPL with 2300 functions available in its 500k read only memory (ROM). There is a graphical Liquid Crystal Display which can be used for alphanumeric or pictorial readout. Each dot or picture element on the screen is addressable under program control. This feature in itself is useful, but the additional feature that makes receiver control possible is the standard serial port available through a four pin connector on the back. HP has thoughtfully provided several functions internally to assist in controlling what passes through the bidirectional serial port.

Control functions are implemented on the Japan Radio Company series of receivers through the sending and receiving of plain ASCII text strings. This makes programming them through the HP handhelds almost trivial. As an example, consider the problem that many of the buttons on the NRD535 are multifunction in the sense that a single button selects a series of options in a "carousel" fashion by repeated key presses. To select any of four filters may require from one to three key presses. However if you find yourself, changing from AM to LSB to USB and back again, while simultaneously changing filters to fit the reception mode, it makes sense to assign single function buttons on the HP48 to AM, USB and LSB. Each function will take care of switching in your favorite filter to simultaneously match the mode. Here is what the program looks like for the AM function.

```
<< 4800 BAUD OPENIO "H1D4B0H0" XMIT DROP CLOSEIO 9600 BAUD >>
```

Notice several things about RPL programs that are quite different from other higher level languages. RPL is very much similar to the language "Forth". Compared to other high level languages, it is very compact. The above program would take up several lines as an equivalent BASIC program. Also, notice that the language is "stack" oriented in that the arguments are entered into the calculator in the order they are keyed in. Functions, as they are called, operate on whatever parameters they find that have been last entered on top the stack. For example, to add two numbers, you enter the first, then enter the second. Pressing the "+" key removes the last two entries, adds them and leaves the result as the last entry. The above program first sets the serial bit rate to 4800 bps, opens the input/output port, transmits a string of ASCII to the receiver, closes the port and finally resets the bit rate to 9600. Those of you who have programmed the NRD525/535 may recognize the string as setting the mode to "AM" and the filter to "Wide".

DATA BASE MANAGEMENT

One unfortunate feature of all receivers with memory is that there is never enough. With the price of semiconductor memory these days, it is surprising that JRC included only 200 storage locations in the NRD535. You can consider the HP handheld as an expansion of the receiver's internal memories and use it both as a controller and a data base manager.

Some useful functions I've implemented include routines to download a list of frequencies to the NRD535, log the current receiver settings into the HP48 for future reference, change modes and filter settings simultaneously and in general, control all the receiver functions that the rich set of commands provided by JRC will allow. Whenever I change one of the dozens of user settable options, I run a program to copy these for restoring later in the event of loss of internal receiver memory. An additional set of commands is available to manage the data files within the calculator, such as to extract lists of frequencies by time and to sort these lists. Thus I can download all known frequencies for a country or limit the search to specified frequencies at specified times. While it is possible to enter and maintain data on the HP48, I've found it easier to build lists of target frequencies on a larger computer and later download the lists to the handheld calculator. I use such data sources as magazines, *Fine Tuning* newsletters and the Internet for keeping current on scheduled frequencies and times.

The accurate internal clock of the HP48 allows setting an almost unlimited number of alarms. When an alarm comes due, you can have a tone sound, or even execute a prepared program. Add the ability to, within a program, turn on the receiver, set a frequency and mode and turn on the tape recorder and you have the ultimate in remote tape recorder control.

AMATEUR PROGRAMMERS

The HP48 is easily programmed by the individual user, so features can be added in the form of custom menu keys that appear on the display. To write a program, no special knowledge of computers is required. A program consists of entering the same keystrokes as are used to perform the functions manually. Thus the computer "language" used by the HP48 is written on the face of the keypad. To someone who has little understanding of the inner workings of a calculator, the ability to create small programs that reduce the need for repetitive keystrokes is somewhat like magic. You may find yourself taking the machine with you when you anticipate periods of spare time, much as you do with a novel or other light reading. Short programs can be entered directly as ideas occur and without the encumbrance of paper and pencil. Later they can be printed either on the HP48's own optional printer or by sending your program to a larger computer with a printer. This should be done anyway as insurance against the loss of memory on the HP48.

A key area needing further exploration by the programmer community is the use of computing devices by the visually impaired. Coupling the radio's feedback to the calculator's sound capabilities would allow any radio with a two way RS232 port to output its status as Morse code. Unfortunately, programs are written by professionals only if there is a sufficient market for them. By making the calculator easy to program, it is possible for part time programmers to adapt it to specialized situations and some of the smaller markets may be filled.

By programming the HP48, you can customize it to your own style of DXing. Here's how I use my system to fill my needs and changing style. For armchair listening I have a file of times and frequencies for broadcasts directed to North America, collected over the years as personal favorites. I let a program select the frequencies active at a given time and step through them looking for clear signals. I can hold the HP48 in one hand and still adjust the manual controls with the other. For DXing the tropical bands I have a list of Southeast Asian and Pacific frequencies that load into the NRD535's internal memories. As these change, it takes about a minute to completely clear the frequencies and reload a current list. The ability to hold more than 200 receiver settings is especially useful when listening to weather FAX and aircraft transmissions. It is possible to step through or scan hundreds of frequencies very quickly while listening for sometimes sporadic activity.

OTHER PROGRAMS AVAILABLE

As in most disciplines, we build upon the works of others. Since the HP48 has been around for over five years, it has built up a following, primarily among engineering and mathematics college students. As you would expect, most programs are the result of students programming around their class work. The Internet has a news group dedicated to this little machine. You can find coming over the wires and airwaves all sorts of home crafted software useful in solving differential equations, designing electrical circuits and handling statistics. In addition, you will find several personal data organizers, calendars, phone books, which are useful to those of us in the real world. There are pocket observatories, and programs to calculate sunrise and sunset, moonrise and set, planetary location, as well as a graphical grayline terminator program similar to that you find on the larger machines. If you travel, or listen to business oriented programming, you will want the currency conversion program that allows you to convert between any two world currencies at a touch. Several Morse code practice programs are available that exploit the sound capabilities of the HP48.

All of these programs are available on what are known as "Goodies Disks." They are available on computer bulletin boards throughout the world, on the Internet via file transfer, on commercial systems such as Compuserve and by mail order. The cost is nominal for the disks or is only the cost of transferring the files by telephone.

AVAILABILITY AND COST

The HP48 is available in several models. The current incarnation is the HP48gx which comes with 128 kilobytes of random access memory (RAM) and would be capable of storing all of the programs I normally use for listening. The predecessor of the "gx" was the HP48sx. It was standard with 32k of RAM and had a few hundred fewer built in functions than the "gx". Both the "gx" and the "sx" can be expanded with another 128k using expansion cards. The HP48sx can accept two 128k RAM modules, and if you really need it, the "gx" can accept an additional 4 megabytes of RAM. Both models are available as the HP48s and HP48g, but since these are not expandable, data and programs would quickly overflow their meager 32k memories. The HP48gx sells for about $275 in appliance stores and college book stores. You may find the HP48sx used for around $125, sometimes with other goodies thrown in. 128k expansion cards are $85 to $125 new. You will also need an RS232 cable for connection to the receiver and to a larger computer for download. The Hewlett-Packard cable package is $50 including software, or you can build your own for about $16 and use your own software. The HP48 uses the "kermit" data transfer protocol which is available in many of the popular communications programs.

The HP48sx comes with a large manual sufficiently detailed for all but the most dedicated users. It is written for both basic users and for those who wish to actually write their own programs. The HP48gx on the other hand has the barest minimum of documentation. Additional help is available in the form of an advanced manual written mainly for programmers. There are other books available that go into much greater depth on many of the features of the HP48 series. Popular among these is a two volume set of "HP48 Insights" Written by Dr. William Wickes, a member of the HP48 development team. These books were originally written for the HP48sx but are excellent discussions of the calculator's applications and inner workings and were not made obsolete by the introduction of the HPgx.

features

SHORTWAVE RADIO IN RUSSIA

John C. Fisher

In the past several years since the breakup of the Soviet Union, the radio scene has become very dynamic to say the least. Gone are the days when all broadcasts from Russia were state controlled. Privately produced programs, independent stations and relays of foreign religious broadcasters, unthinkable 4 years ago have now become the norm.

In addition to the increase in radio broadcasting activity, there has also been an increase in the number of active DX'ers who regularly communicate with their counterparts outside of Russia. It is largely a result of their activity and reports that much of the data in this article has been possible.

This article will focus on shortwave radio in Russia only. State broadcasters from the newly independent Republics as well as any private radio there are not included in this report. The highly active medium wave and FM likewise will not be addressed.

TRANSMITTER SITES

Before the breakup of the Soviet Union, little was known about the location of transmitter sites used by Radio Moscow and the other broadcasters from the Soviet Union. Many of the services from the Republics (Vilnius, Tashkent, Alma, Ata etc.) were believed to have originated from the cities where their studios were, but nobody knew for sure.

With Radio Moscow, we were even more in the dark. Except for some Western government agencies and location estimates from services like BBC Monitoring, most of us had to rely on verifications from Radio Moscow to tell us where the transmitters were located. We were truly at their mercy; if they said that the frequency in question was broadcast from Gorki, how were we to know any better?

In recent years, as the country has opened up and travel has become freer, much more has been learned about the true location of these sites. A summary of Russian transmitter sites QSL'd by US DX'ers published in the August 1976 FRENDX showed 40 different sites in Russia; 21 in the European section and 19 in Asia. A recent survey compiled by Anatoly Klepov of Moscow shows that the current number of high powered Russian transmitter sites is 26, with 15 in Europe (Figure 1- Map showing High Powered site locations). Whether there are really fewer sites in use in the 1990's or whether a number of the sites quoted in the past never existed is not known. Probably a bit of both.

One of the factors which has contributed to the confusion in knowing where transmitter sites are located is that there have been a large number of name changes of Russian cities. Most cities which had been named for leading Soviet and Eastern European Communists have reverted to their pre-Bolshevik Revolution names. Of the cities which currently have transmitters, or those which had broadcast facilities in the past, the following name changes have taken place.

Old Name	New Name
Kalinin	Tver
Kuibyshev	Samara
Leningrad	St.Petersburg
Sverdlovsk	Yekaterinburg
Gorki	Nizhrj Novogorod
Stalingrad	Volgograd

One very interesting transmitter site is the Boishakovo site in the Kaliningrad enclave. This region used to be called Konigsberg and was part of Germany (East Prussia) until the end of World War II. After the war, it was divided, with half going to Poland and the other half going to Russia. It is now a non-contiguous piece of Russian territory separated from the main part of the country by Lithuania. As yet it is not considered a separate radio country, but could be worthy of consideration in the future.

According to Russian DX'er Mikhail Tomofeyev (via the DSWCI *Shortwave News*), the State Broadcast Radio Communication Company 2, in St. Petersburg, informs listeners that programs relayed via their centers in St. Petersburg and Kaliningrad will be verified by a special QSL card. Reception reports should be sent with 2 IRC's to: GPR-2 Verification QSL service, Akademika Pavlova St. 13A, 197376 St. Petersburg. Both sites have an extensive schedule of Radio Moscow, Mayak and Radio Rossiya programs, but the best bets for North American listeners would be : Kalinin-

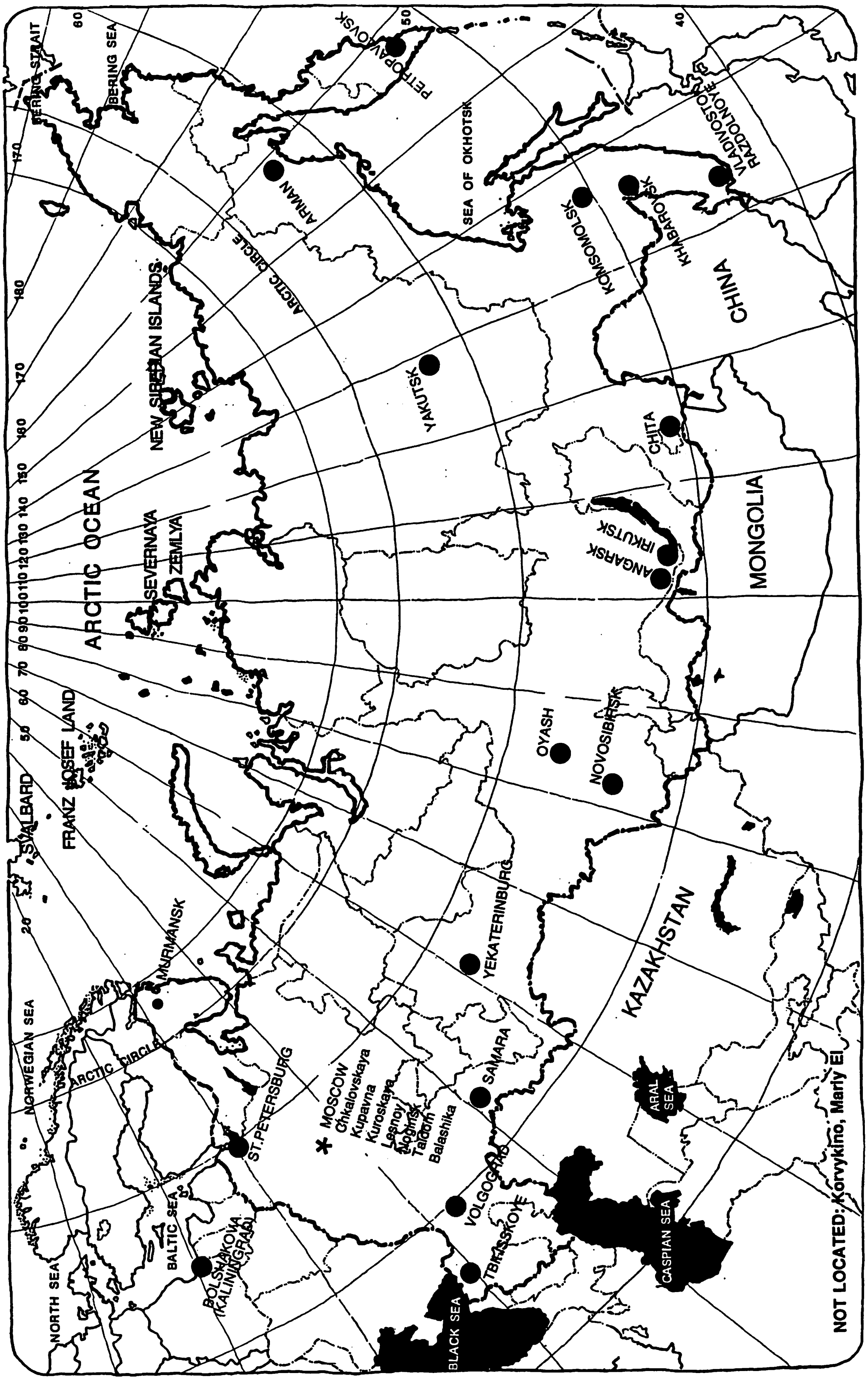


FIGURE 1. HIGH POWERED SHORTWAVE TRANSMITTER SITES

grad 5905 0500-0800, 9680 0830-1100 with Radio Moscow programs and 7225 0200-0530, 15360 0600-1400 with Radio Majak. St. Petersburg is listed on 5950 2130-2300, 7300 2200-2300, 9705 0200-0600, 9890 1300-1900, 12070 0830-1300 all with Radio Moscow programs.

Table 1.

High Powered Russian Transmitters

LOCATION	POWER (kw)	SERVICES
EUROPEAN RUSSIA		
Kurovskaya (Moskovskaya Obl.)	100/150/250	Foreign, Home
Noginsk (Moskovskaya Obl.)	120	Home
Chkalovskaya (Moskovskaya Obl.)	100	Foreign, Home
Kupavna (Moskovskaya Obl.)	100	
Taldom (Moskovskaya Obl.)	100/150/250	Foreign, Home
Lesnoy (Moskovskaya Obl.)	250/500	Foreign, Home
Balashika	20	Republic,Private
Murmansk (Murmanskaya Obl.)	50	Home
Tbilisskoye (Krasnodarsky Kray)	120-1000	Foreign, Home
Volgograd (Volgograd Obl.)	100	Foreign, Home, Private
St. Petersburg (Leningrad Obl.)	200	Foreign, Home, Relays
Samara (Tatarstan Republic)	50-250	Foreign, Home, Relays
Yekaterinburg (Yekaterinburg Obl.)	100	Foreign, Home, Relays
Kovylkino (Mordovia Republic)	80/120	Home
Bolshakovo (Kaliningrad Obl.)	50/100	Foreign, Home
ASIATIC RUSSIA		
Novosibirsk (Novosibirsk Obl.)	60-200	Foreign, Home, Relays
Oyash (Tomskaya Obl.)	500-1000	Foreign, Relays
Angarsk (Irkutskaya Obl.)	250/500/1000	Foreign, Relays
Irkutsk (Irkutskaya Obl.)	50/100	Home
Chita (Chitinskaya Obl.)	500/1000	Foreign, Home, Relays
Khabarovsk (Khabarovski Kray)	50-200	Foreign, Home
Komsomolsk (Khabarovski Krey)	100/200	Foreign, Home
Razdolnoye (Primorski Kray)	120-1000	Foreign, Home
Petropavlovsk-Kamchatsky (Kamchat Obl.)	100/250	Foreign, Relays
Arman (Magadanskaya Obl.)	50	Home
Yakutsk (Yakutia ASSR)	15/100	Home

A remnant from the days of the old Soviet Union is the sharing of transmitter sites for different services (Table 1). In addition to carrying Radio Rossiya, regional programs and independently produced programs on the same frequency from the same site, programs from the former republics such as the Ukraine still use Russian transmitters. An example of this which can be heard in North America is the use of 6010 kHz by Radio Ukraine via Balashika in Russia. Until recently, Radio Vilnius was relayed on 7150 kHz from Krasnodar in Russia but financial difficulties in Lithuania have curtailed the use of Russian transmitters. The financial health of radio stations has become a contributing factor to the rapidly changing Russian radio scene as we shall see.

Conversely, Russian services are also broadcast over sites in the Republics. Radio Moscow uses transmitters throughout the Republics to expand its coverage. Kharkov in the Ukraine transmits Radio Moscow programs on 4795 kHz from 2100 to 2300 UTC. The Yangi-Yul site in Tadzhikistan carries the Radio Yunost Home Service program from Moscow on 4740 kHz.

Regional services are carried on a number of lower powered stations which may be from the city or region that they are serving. Most of these services also carry the Radio Rossiya program to the regions and use 50 kw or less. More about these later.

I. GOVERNMENT STATIONS

1. Radio Moscow External Services

For those of us who grew up listening to Radio Moscow during the cold war, the changes which have occurred to this bastion of the airwaves has been astounding. As recently as the late 80's, it was possible to tune into a Radio Moscow English language broadcast at almost any hour of the day on almost every shortwave band. Often their North American service seemed to extend over entire bands, so many channels were used. However, the economic crunch of the past few years have significantly reduced Radio Moscow's output. A check of the 1989 WRTH showed 218 hours/ week of programming in 60 languages. By 1994 this had reduced to 151 hours/week in 45 languages including its World Service in Russian called Golos Rossiya.

Radio Moscow uses the transmitter sites indicated in Table 1. A program schedule requested from the station or the WRTH would provide the best listing of their current broadcasts.

Table 2.

RADIO 1 HOME SERVICE			
ORBITA 1 (1800-1600 UTC)			
12070	2245-0700	6200	1800-1600
11815	2145-0600	6175	0730-1600 1800-2115
11740	2230-1500	6090	0730-1600 1800-2115
9780	2145-0700	6035	0730-1230 1800-2215
7160	1800-2000		
6200	1800-1600		
ORBITA 2 (2000-1800)			
15460	0045-1100	7355	1100-1800
12060	0145-1215	7230	1130-1800 2000-0115
11825	2245-1115	6195	1230-1800 2000-0115
11665	0130-1030	6060	2000-1800
9615	1230-1800	5980	2000-0115
9575	0045-0930	5910	1000-1800 2000-0015
ORBITA 3 (2200-2000)			
15225	0330-1115	9450	0030-0830
11750	0230-1200	7400	2200-0200
11700	1130-2000	7110	1230-2000
10855	2200-2000 Mayak)	7100	2200-1100
9820	1200-1300	6195	1530-2000 2200-0100
9605	0130-1500	6135	0900-2000 2200-2400
9555	2300-0300	5935	2200-2000
ORBITA 4 (0000-2200)			
15185	0430-1330	11725	0000-1530
12000	0330-1315	9630	1400-2200
11965	1600-2200	7160	0000-0400

2. Ostankino Home Services

In addition to producing Radio Moscow International programs, the government funded Ostankino company (named for the Moscow district where its studios and TV towers are located) produces a number of programs for broadcast throughout Russia and some of the former Republics. These programs are carried over many External Service transmitters and are some segments are retransmitted between programming blocks on the regional services. Four main services are carried :

Radio 1: A general program carried throughout Russia for 22 hours/day. Five time-shifted editions of this program are carried starting at 1800, 2000, 2200, 0000 and at 0200 UTC. These services cover the vast nation from east to west and are referred to as Orbita 1 through 4 and the European edition, respectively. This program replaced the former All Union Radio service. Table 2 at the left shows their most recent schedule.

Radio Yunost: The youth channel which carries music and programming targeted at the younger generation. The program is carried 24 hours/day.

Radio Mayak: One holdover from the pre-Gorbachev days, this station's name translates to "Lighthouse". It carries all kinds of music, sports and other general programs. News and weather is carried on the hour and half-hour after its distinctive interval signal.

Radio Orfey: A cultural program for Europe which carries drama and classical music from 0300-2100 UTC.

3. Radio Rossiya

Radio Rossiya or Russia's Radio, along with Ostankino's Radio 1, is one of the main domestic services serving all of Russia with 5 time shifted programs. For the regional services, most of its broadcast day tends to be filled with Radio Rossiya relays, with only a small part of the schedule devoted to local programming. Radio Rossiya is also heard on a number of Radio Moscow transmitters including 12175 USB which is often heard during our local daytime, 1400 to 1700 UTC. Programming tends to be dominated by news and current affairs programs.

4. Independently Produced Programs Broadcast Over Radio Moscow

This is where keeping track of the changes in broadcasting gets either interesting or becomes a nightmare, depending on your perspective.

Over the past several years there has been a profusion of programs prepared by a number of political and religious groups for broadcast over Radio Moscow facilities. It appears that to ease its financial crunch, Radio Moscow has been selling air time to groups both inside and outside of Russia. Ads have even been heard on Radio Moscow hawking time slots to whoever would buy them.

The fragmentation of audiences which has been experienced in the West with the proliferation of specialty media services is also happening in Russia. In the West this fragmentation is driven by developments in technology but, in Russia, it is the result of less media control by the State.

Some of the programs broadcast material which is openly critical of other foreign governments such as the anti-Vietnamese program, Radio Hy Vong, and come close to being a clandestine broadcast. But, whatever you call them, these programs are interesting.

While the current schedule of these programs is included in Table 3, you will need to be vigilant to find them as they frequently change schedules and frequencies. The schedules here reflect the winter period and many move one hour earlier during the Russian summer season.

As an example of how fast this area of Russian broadcasting has changed over the past few years, one need only look back to early 1992. At that time I wrote an article for DX Ontario about private radio in Russia and listed 8 stations which either had their own transmitters or had programs broadcast via Radio Moscow. As of January 1994, none of these programs were still on the air. Gone were such early pioneering private programs as Business Radio Rezonans (now Radio Bumerang on MW), Radio Station New Wave (now part of Radio 1) and Echo of Moscow (on MW and FM). Such is the speed at which Russian radio changes.

Radio Slavyanka

On August 6, 1993, the Russian Federation's Ministry of Defense began a joint service with Radio Moscow International for servicemen based in Tadzhikistan stationed on the Afghan border and for ethnic Russians in the area. This service was expanded on November 1, 1993 to include troops still stationed in the Baltic Republics, Kaliningrad Oblast, the Caucuses and Central Asia. Two of the channels used by this service, 4740 and 4975 originate from Yangi-Yul in Tadzhikistan. The station's address is: Ulitsa Mashala Shaposhinkova 14, Moscow K-160.

Voice of the Assyrians

Not much is known about the Moscow Assyrian Community which is behind this service which came on the air in mid '93, broadcasting in Assyrian, Persian, Arabic and Russian. Hans Johnson, an expert in broadcasting from the Middle East sheds a little bit of light on the Assyrians. They are a Christian minority group that now inhabits parts of several Middle Eastern countries including Syria, Iraq and Iran and until early in this century controlled an empire in Southern Iraq. If you should hear them, try the Radio Moscow address of: ul.Pyatnikskaya 25, 113326 Moscow.

Radio Rukhi Miras

Rukhi Miras is the program prepared by the Islamic Center of Moscow which broadcasts in Tatar the indigenous language of Tataristan, an Autonomous region, east of Moscow near the Ural mountains. The station's address is : Sheikh Ravil Gainutdin, Islamic Center of Moscow Region, Moscow Jami Mosque, Vipolzov by-str 7, 129090 Moscow.

Radio Stansiya Nodezhda (Radio Station Hope)

This station is reported to be the mouthpiece of the Women's Public Organization in Russia. It was set up by the Russian Womens Union and a charitable fund "The International Foundation For The Protection of the Health of Mother and Child" and has been heard with a 4 hour program broadcast at 0700 to the Far East, 1100 to Russia, 1500 to European Russia and Central Asia and at 2000 with to Europe on a number of shortwave channels, all in the Russian language. For reports try the Radio Moscow address.

Radio Radonezh

This is the station of the Russian Orthodox Church which broadcasts daily for 1 hour from the transmitters at Yekaterinburg. Address is Studio 158, ulitska Pyatnitskaya 25, Moscow 113326.

Radio Galaxy

When it came on the air in 1991, Radio Galaxy probably epitomized the changes which were underway in the old Soviet Union. Never before had we heard a shortwave station from Russia broadcasting commercials (albeit clumsy commercials by western standards). The station's programming consisted of pop music with occasional commercial advertisements for Moscow area businesses (generally looking for Western partners and money) in English. Reception on 11880 or 9880 kHz used to be quite reliable in the late afternoons around 2100 UTC, however it has not been heard recently and is reported inactive. Address is P.O. Box 7, Moscow 117418.

Table 3.

Independently Produced Programs Aired Over Radio Moscow

PROGRAM	TIME/DAY	FREQUENCY
Radio Slavyanka	0100-0300 Tu-Sun	9540, 9490, 9480, 7390, 7310, 7160, 4975, 4940, 4740
	1600-1800 M-Sun	12025, 12015, 9890, 9540, 7310, 4975, 4940, 4740
Voice of the Assyrians	1600-1700 W, Sa	7305, 12075, 17890
Radio Rukhi Miras	1600-1645 F	4055, 12075, 17890
Radio Nadezhda	0400-0700	5915, 5935, 6015, 7140, 9490, 9625, 9730, 11670, 11740, 11805
	0700-1100	5915, 5935, 7140, 9490, 9635, 9725, 9730, 11665, 11670, 15120, 15230, 17560
	1100-1500	5915, 5935, 7420, 9490, 11665, 11705, 15230
	1500-2000	5935, 6015, 7420, 9490, 9590, 9725, 11705, 11855, 11985, 15340, 17675, 11885
		11985, 15340
	2200-2400	6015, 11985, 15340
Radio Radonezh	1600-1700	9865
Radio Galaxy (inactive?)	2100-2200	9880, 11880
Radio Alef	1600-1700 Tu, Th, Su	4055, 5905, 12075, 17890
Radio Alpha & Omega	1500-1600	9865
Radio Center	0630-0700	12010
	1630-1700	11735
Voice of Islam	0625-0700 F	7265, 8005 USB, 9595, 9720, 11720, 11780, 11905, 11990
Radio Risalah	0800-0900	15550, 17635, 17710
Radio Aum Shinrikyo	0430-0500	Many
	2130-2200	Many
	1600-2200	7160

Radio Alef

Radio Alef (named for Alef, the Hebrew letter A) is a joint venture between Radio Moscow and the Jewish Childrens Association, Banim Banot. The service is announced as being for Moscow city, Moscow oblast and Israel and carries advertising and occasional announcements in Hebrew. Their address is P.O. Box 72, 123154 Moscow.

Radio Alpha and Omega

Christian Radio Station Alpha and Omega is sponsored by the Protestant Publishing House, Mukomol'nyi pr. 1 korp. 2, Moscow 123290.

Radio Center

This station started broadcasting from Radio Moscow facilities in early 1993. It is unique in that for its signon it has a tape of an announcer repeating the station's name over and over again for a minute or two. There were reports in 1992 that the owners of the now departed Radio Space were opening up a new "station" called Radio Center, so this is likely the result of that work. Address is : ul. Nikolskaya 7, 103012 Moscow.

Voice of Islam

Not much is known about this program which is broadcast for 35 minutes on Fridays on a number of Radio Moscow channels. I have only listed the lower frequencies which might propagate to North America, but be aware that there are a number of other channels where they can be heard.

Radio Risalah

This station goes by several names including Radio Risalah in Arabic, Radio Poslaniye in Russian and Radio Message in English. Their programs consist of material from foreign press agencies, the Russian ITAR-TASS news agency, the Islamic Herald and Radio Moscow. Reports can be sent to "Al-Risalah - The Message", ulitsa Pyatnitskaya 25, 113326 Moscow

Radio Station Pamyat

This station which began operating in late September 1991 is sponsored by an extreme right-wing group in Russia. The name of this station means "memory" and is the voice of the Russian national/patriotic front. This group blames the Jews and the Masons for the situation that Russia is in. During the crisis of early October 1993 where

Yeltsin's forces retook the Russian parliament, this station was closed down by decree of President Yeltsin. It is still shut down because of financial difficulties, but the station has indicated that it plans to return to shortwave. Its address is: Radio Station Pamyat, P.O. Box 23, Moscow 113535.

Radio Aum Shinrikyo

This rather bizarre station is the voice of a Japanese religious sect. Its 30 minute English program, produced in Japan is called "Euagerion Tess Basheriesu" which means "The Announcement of the Absolute Gospel of the Holy Heaven of the Propagation of the Absolute Truth of the Holy Heaven" (or words to that effect). They have some unusual readings from the writings of their founder Shoku Ashihara and almost hypnotic chanting music. The broadcast is hard to miss as it makes use of most of Radio Moscows facilities twice a day at 0430 and 2030. In fact the 1994 WRTH reports them on no less than 48 channels at 0430. If you can stay awake for their entire broadcast, their address is given at the end as 381-1, Hitoana, Fujinoniya, Shizuoka, Japan 418-01.

Radio Hy Vong (Radio Hope / Radio Nadezhda)

In 1992, a group opposed to the current Vietnamese government set up a program called Radio Irina. This program was well heard in North America from 1400 to 1500 UTC on 15580 kHz. However, in July 1993 it was shutdown for "political reasons". In its place, sprouted Radio Hy Vong on July 19, 1993. It broadcasts in Russian on Wednesday and Thursdays and in Vietnamese on other days. It is not known whether the same group that produced Radio Irina is behind Radio Hy Vong as well. If you want to try reporting to them, Radio Irina's old address may be worth a try. It is ul. Novinskiy 18/257, 121069 Moscow.

II. "INDEPENDENT" STATIONS

1. Regional Services

Most of the major cities and regions (oblasts) throughout Russia have their own locally produced and transmitted programs which are aired over medium and short wave transmitters for the local audience (Figure 2). Generally the transmitters for these services are much lower in power than are Radio Moscow's. The Tura site in Siberia operates with only 1.5 kW, while the powerhouses in Vladivostok, Chita and Petropavlovsk use 100 kW. Most, however, use about 50 kW.

These regional services are carried for several hours per day on transmitters which are shared with various national services (primarily Radio Rossiya but also Radio 1, Radio Yunost and Radio Mayak). Most stations are on the air for a total of 20 to 23 hours per day, signing off only for a couple of hours during the middle of their local night. Since the broadcasting schedules of their locally produced programs tend to be fragmented in programming blocks varying from 15 minutes to several hours, only the frequencies of broadcast are listed in Table 4. Time of their local broadcasts can be found in the WRTH.

It is hard to say just how independent these stations are, considering that almost all of them carry at least some Ostankino programs. One indication though that they have some autonomy is that on January 20 the transmitters in Petropavlosk-Kamchatsky and Anadyr were switched off until their electricity bills were paid. At the same time some Moscow area transmitting centers, Vladivostok and Chita were given warnings that they could be switched off as well. This threat already seems to be having an impact at Vladivostok as their 5015 kHz frequency is now on the air for only 10 1/2 hours/day compared to its previous 23 hour broadcast day.

2. Independent Stations

After the fall of the Soviet Union in 1991 there was a real rush of entrepreneurs who scrambled onto the air with their own stations. In many cases these stations broadcast news and pop music which was not available on the government run stations, but also seemed to reflect the egos of the personnel behind the ventures. Both Radio Ala and Radio SNC took their names from the initials of their owners.

The greatest number of these new stations were from the Moscow area. This was especially so on medium wave and FM where there has been a profusion of western styled rock music stations.

Unfortunately the "bloom seems to be off the rose" for these stations, at least on shortwave. Whether the reason is the escalating costs of station operation or bureaucratic red tape, the number of independent shortwave stations has dramatically reduced in the past year. Gone are such stations as Radio Ala, Radio Polis, Radio SNC and Radio New Wave. Those stations that do remain are quite difficult to hear and as such not much is known about many of the currently active stations listed in Table 5.

3. Foreign Broadcasters in Russia

In an effort to bring in foreign cash to Russia, the state has offered the many Radio Moscow transmitters for use of foreign broadcasters. To many broadcasters, this is a great opportunity to reach the huge populations of East and South Asia from the ideally located transmitters in Siberia and Kazakhstan.

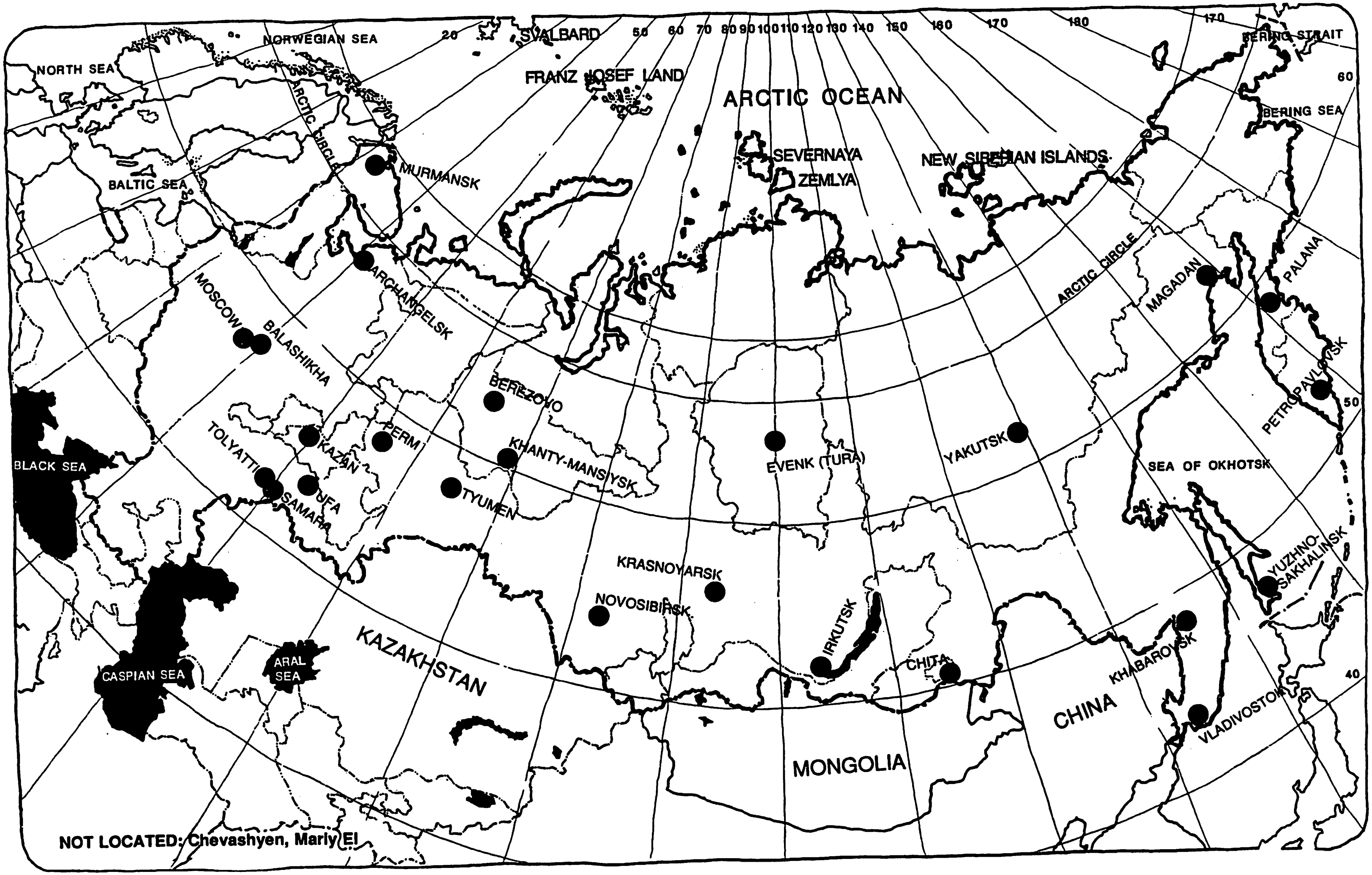


FIGURE 2. RUSSIAN REGIONAL STATIONS

Regional Services

STATION	FREQUENCY	POWER (kW)	HOURS/DAY FOR LOCAL SERVICE	TOTAL BDCST. DAY (UTC)
Novosibirsk (Kazakh R)	3955		23	0000-2300
Evenk	4040	1.5	2	0030-
Yuzhno-Sakhalinsk	4050 USB	50	3	1800-1600
Moscow	4055	60	4	0200-2400
Petropavolsk	4485	100	4	1800-1600
Ufa (Bashkir R)	4485	50	5	0000-2200
Khanty-Mansiysk	4520	5	0	0000-2200
Palana (Koryak R)	4520	5	1	2000-0800
Khabarovsk	4610	15	7	2000-1800
Yakutsk	4800	50	3	2000-1800
Yakutsk	4810			2000-1800
Khanty-Mansiysk	4820	50	3	0000-2200
Yakutsk	4825	50 (Winter)	3	2000-1800
Chita	4860	100	5	2000-1800
Tyumen	4895	15	3	0000-2300
Yakutsk	4920	50	3	2000-1800
Yakutsk	4940	50 (Winter)	3	2000-1800
Vladivostok	5015	50	4	2030-0700
Berezovo	5070	1	Sun.	0330-0700
Krasnoyarsk	5290	50	3	2200-2000
Perm (R Rossiya)	5290	20	0	
Murmansk	5930	50	3	0200-2400
Novosibirsk (Radio 1)	5935		0	
Magadan	5940	50	4	1700-1500
Magadan (Anadyr R)	5940	50	3	0200-2400
Khabarovsk	6060		6	
Irkutsk	6090	50	3	
Tolyatti (Tatar R)	6115	5	8	0300-1530
Kazan (Tatar R)	6120	20	8	
Mariy El	6125		3	0330-1800
Arkhangelsk	6160	15	2	0200-0000
Perm (Kudymkar R)	6165	3	2	0000-2200
Yakutsk	7140	50	3	2000-1800
Perm(Tatar R)	7185	3	8	0200-1745
Yakutsk	7200	50	3	2000-1800
Mariy El	7200	3	2	0200-1400
Khabarovsk	7210	50	7	2000-1900
Yakutsk	7265	50	3	2000-1800
Magadan	7320	50	4	1500-1300
Yakutsk	7340	50	4	1700-1500
Magadan (Anadyr R)	9600	50	1	0815-0900
Chita	9720	5		
Chevashyen	9875	4		0315-1900?
Perm (Kudymkar R)	11770	3	1	1400-2200
Yuzhno-Sakhalinsk	11840 USB	50	3	1800-1600
Samara (Tatar R)	11905	2		1630-1900
Tolyatti (Tatar R)	11920			
Balashikha (Tatar R)	11945	20		
Perm (Tatar R)	15200		3	1800-2100
Murmansk	15350	3		
Balashikha (Tatar R)	17810	20		

Table 4.

Among the first broadcasters to use Russian transmitting facilities were the religious broadcasters Far East Broadcasting Corporation and Adventist World Radio. In March 1992, FEBC established Russian, Korean and Chinese services on shortwave using the facilities of the former Dalny Vostok Radio in the Far Eastern city of Khabarovsk. Their facilities consist of a 20 kW former jamming transmitter and an office/studio in Khabarovsk. An FM network for Siberia headquartered in Novosibirsk and a nation wide medium wave service centered in Moscow ensure wide coverage in the country.

Independent Stations

STATION	LOCATION	TIME	FREQUENCY
Radio Vostok	Khabarovsk	0600-0730	5010, 7210
Radio Centr	Krasnoyarsk	0300-0330	5290
Radio Diapazon	Perm	0330-0400	5290
U Radio	Moscow	1700-0100	5900
Radio Vedo	Volgograd	0400-0800 (Sat/Sun)	5975, 13710
		1400-1700 (M-F)	5975, 13710
Radio Lena	Yakutsk	0300-1000	5920, 6125
Radio Yakutsk	Yakutsk	0500-1300	5920
Radio Novya Volna-2	Chelyabinsk	0700-1500	6020
Radio Nika M-4	Murmansk	1000-1200	6030
Radio Dvizhenie	Yekaterinburg	1300-1700	6090
Radio Vesj Irkutsk	Irkutsk	0500-0600	6090
		1100-1200	6090
		2330-0030	6090
Radio N	Yekaterinburg	0500-0600 (Tue-Sat)	6200
		0700-1100 (Tue-Sat)	6200
Radio M	Yekaterinburg	0600-0700 (Tue-Sat)	6200
		1230-1330 (Tue/Wed/Sat)	6200
Radio Channel Uralskiy	Yekaterinburg	1200-1300	6200
	Commercheskiy	1530-1600	6200
Radio 7	Samara	0400-0630 (Mon-Fri)	6130
		1200-1400 (Mon-Fri)	6130
		1000-1500 (Sat)	6130
		1200-1500 (Sun)	6130
		0100-0300 (Mon-Fri)	9550
		0700-0900 (Mon-Fri)	9550
		0500-1000 (Sat)	9550
		0500-0800 (Sun)	9550
Radio Republic of Sakha	Yakutsk	0800-1000	7215
		2000-2200	7215

Table 5.

Later in March 1992, a second religious broadcaster started its shortwave service from Russia. Adventist World Radio Europe now broadcasts from Moscow, Samara and Novosibirsk. Until recently they also used the transmitting complex in Yekaterinburg, however, they have dropped this site due to a steep increase in costs of electricity being charged to relay stations. Hopefully this will not be a sign of things to come.

One of the more unusual broadcasters to take to the Russian airwaves has been the American preacher Dr. Gene Scott. He too set up Russian relays of his programs via Novosibirsk and Samara in 1992 and is now heard at various times of the day on 6070, 6120, 11840, 12040, 15315, 21485 and 21670 kHz, although none of these channels are regularly reported in North America.

Unlike these religious broadcasters, the International shortwave broadcasters which use Radio Moscow's transmitters do not maintain offices and studios in Russia, they simply lease their time on these transmitters. According to Russian DX'er Nikolai Rudnev, as of the end of 1993, ten stations were leasing time on Radio Moscow shortwave facilities in the CIS, mostly in Russia.

Deutsche Welle	130.9 Freq. Hrs./Wk.
Radio Nederland	98
BBC	71.8
VOA	31.5
China Radio Int'l	31.5
Radio France Int'l	14

<u>Religious Broadcasters</u>

University Network	182
AWR	73.5
TWR	28
World Christian Corp.	6

VERIFICATIONS

In general, QSL's from the independently produced programs and from Russian stations in general have tended to be few and far between. This is likely due to the poor state of the postal service in Russia. Many letters do not arrive at their destination and replies do not make it out of the country. Letters which I have received from Russia have shown signs of obviously having been opened, so caution and persistence are needed when searching for QSL's.

In a number of cases (especially for Moscow based programs), the Radio Moscow address of ul. Pyatnitskaya 25, 113326 is used and could be considered as an address of last resort if a location for the station is not known.

FUTURE PLANS?

In a country that is undergoing as much political and economic change as Russia, predicting the future of its radio developments is a mugs game where you will almost certainly be wrong. Will the numbers of international broadcasters being relayed on Russian transmitters increase as the state tries to bring in more foreign cash or will escalating energy costs drive them out? Similarly will private broadcasters back away as costs rise, or will the opportunity to broadcast their own particular message be too attractive to pass up?

Will political and ethnic tensions in the oblasts and Russian Republics lead to dissident radio stations to support the local causes? A couple of Republics to watch in this area are oil-rich Tatarstan, which has many shortwave transmitters to draw upon and the Chechen and North Ossetia Republics near Georgia. Treaties have now been signed which make Tatarstan a sovereign republic in voluntary confederation with Russia. As such, Tatarstan can secede whenever it wishes. The mineral rich Yakutsk region has also expressed desires towards independence.

Unlike the oblasts (regions) which send 55% of the revenue that they collect to Moscow, Tatarstan and its neighboring Republic of Bashkarostan send no revenue to Moscow. Because of this type of inequality, the regions are talking of banding together into loose alliances to become Republics which would have more rights than the regions do. In the center, 11 regions are talking about forming the Central Russian Republic. In the industrial belt of the Urals, there is talk of a Ural Republic. In the east, leaders are talking of Siberian and Far East Republics. Where changes in political power and control occur, the media (including radio) often change as well, so activity in these areas is a possibility.

Finally, with the current political situation in Moscow being anything but stable, could radio services supporting views opposed to President Yeltsin start to spring up? Will the recently elected Vladimir Zhirinovsky establish a radio voice for his right-wing views?

While the future direction of radio in Russia may not be clear, it certainly will be interesting and will bear watching in the months and years to come.

ADDENDUM

Just before this article went to press, it was reported on Radio Nederland's *Media Network* that a large number of the shortwave relays of regional services (see Table 4) went off the air on July 28, 1994, although many of them returned to the air a couple of days later. In addition it appeared that Radio Rossiya and Ostakino services (Majak, Radio 1, Radio Yunost) had dropped their shortwave channels above 6 MHz, although these have not been confirmed.

ACKNOWLEDGMENTS

I would like to acknowledge the help of a number of DX'ers who have provided me with station information for this article and helped verify the info presented here. These include Jerry Berg, David Clark, Harold Sellers, Grigory Grigoriev of Slantzy, Russia and Anatoly Klepov, Moscow. In addition a considerable amount of the station information was originally provided by the BBC Monitoring Service and edited by Hans Johnson in the *Listeners Notebook* column in the "Journal" of the North American Shortwave Association (NASWA).

WHAT WOULD THAT COST, TODAY?

John H. Bryant

Over the years that I have been interested in vintage radio, one of the questions that I've asked myself most has been 'What would that cost, today?'. In many ways, that is a fool's question. If someone actually set up a plant today and started manufacturing major Hallicrafters, Hammarlund or Collins shortwave receivers, or Zenith 'Big Black Dial' consoles, probably none of us could afford to buy one of them. Paying modern wage rates for point-to-point wiring, hand assembly and fine hand craftsmanship would surely make one of them a good bit more expensive than the average satellite TVRO down-link.

There is another way to look at that question, though; you could ask what one of those old tube-type beauties would cost in 'modern' dollars. We all know about 'inflation' and many of us remember when gasoline was less than 30 cents per gallon. Thinking about all of this, I became sure that there was some reasonable way to figure what these things cost in 1994 dollars.

I'm a university professor and I thought that somebody in the College of Business would be able to help me in this quest. I was soon making friends with the Economics faculty. They were kind enough to develop the Weighting Factors that follow. It seems that the government publishes "Consumer Price Index" tables annually; although the 'CPI' tables that the government publishes only go back in time a decade or so, my new friends in the Economics Department were able to link several of them together to reach back to 1942. A half century of inflation passed before my eyes! The Weighting Factors that they developed, based on the CPI, counts 1994 dollars as a base. The formula for determining past prices as expressed in 1994 dollars is:

Price in 1994 dollars = Price in 'N' year X Weighting Factor for 'N' year

1994 BASE = 1.00

YEAR	WEIGHTING FACTOR	YEAR	WEIGHTING FACTOR	YEAR	WEIGHTING FACTOR
1942	9.264	1958	5.242	1971	3.741
1946	7.770	1959	5.207	1972	3.624
1947	6.794	1960	5.118	1973	3.412
1948	6.287	1961	5.067	1974	3.074
1949	6.365	1962	5.017	1975	2.817
1950	6.287	1963	4.952	1976	2.662
1951	5.828	1964	4.887	1977	2.500
1952	5.718	1965	4.810	1978	2.324
1953	5.675	1966	4.676	1979	2.087
1954	5.632	1967	4.536	1980	1.839
1955	5.653	1968	4.353	1981	1.666
1956	5.571	1969	4.129	1982	1.570
1957	5.392	1970	3.905	1994	1.0000

EXAMPLE:

Raymond Moore lists the 1954 introductory retail price of the Hallicrafters SX-99 as $199.95.

1994 SX-99 price equivalent = $199.95 (the 1954 price) X 5.632 (the 1954 Weighting Factor) = $1126.12

No wonder I had to work so hard flipping hamburgers for $.50 per hour (now $2.82) to buy my SX-99!

I'm sure that some other economists would quibble at the process that my friends in the College of Business used to link together several published CPI's to reach clear back to 1942. The major danger in applying a CPI based weighting factor to specific products is that the CPI is, itself, an *average* of many consumer product prices. In the past 50 years, labor or skill intensive items have risen in price much more than products whose manufacture is largely automated.

Don Jensen recently offered an excellent example:

In 1950, I was in 9th grade. My dad bought one of the first TV sets in town (apart from those in taverns), a 10 inch RCA, and paid $450. I also was injured in an auto accident and spent 8 days in the hospital, after surgery. I came across that bill last year in some old papers. He paid $256.

However, the Consumer Price Index is the only relatively easy basis to use to develop a Weighting Factor for long term inflation. The table below lists the prices at introduction of a number of familiar tube type receivers along with that price converted to 1994 US dollars. With the exception of the Zenith Trans-Oceanics, the retail prices were taken from the new 3rd Edition of Raymond Moore's *Communications Receivers.*

MANUFACTURER	MODEL	YEAR	RETAIL PRICE	CONVERTED TO 1994
Beginner's Receivers				
NATIONAL	SW-54	1951	$49.95	$291.11
HALLICRAFTERS	S-38	1946	$39.50	$306.92
HALLICRAFTERS	S-120	1961	$69.95	$354.69
All-Wave Portables				
HALLICRAFTERS	S-72	1949	$79.95	$508.88
ZENITH	TRANS-O	1954	$140.00	$788.48
HALLICRAFTERS	TW-1000	1953	$149.95	$851.25
ZENITH	TRANS-O	1946	$124.00	$963.48
ZENITH	TRANS-O	1958	$250.00	$1310.50
Lower Mid-Price Receivers				
HALLICRAFTERS	S-40	1946	$79.50	$617.72
HALLICRAFTERS	S-85	1954	$119.95	$675.58
Upper Mid-Price Receivers				
HAMMARLUND	HQ-129X	1946	$129.00	$1,002.33
HALLICRAFTERS	SX-99	1954	$199.95	$1,126.40
HALLICRAFTERS	SX-71	1949	$179.50	$1,142.52
NATIONAL	NC-173	1947	$189.50	$1,287.46
DRAKE	SW-4A	1966	$299.00	$1,398.12
HAMMARLUND	HQ-145	1959	$269.00	$1,400.68
HALLICRAFTERS	SX-100	1955	$295.00	$1,498.05
Top of the Line Listener's Receivers				
HALLICRAFTERS	SX-62	1948	$269.50	$1,694.35
HALLICRAFTERS	SX-62A	1955	$350.00	$1,978.55
HALLICRAFTERS	SX-62B	1965	$525.00	$2,525.25
Top of the Line Communications Receivers				
DRAKE	R-4B	1968	$430.00	$1,871.80
NATIONAL	NC-183D	1952	$369.50	$2,112.80
NATIONAL	HRO-7	1947	$311.36	$2,115.38
HALLICRAFTERS	SX-42	1946	$275.00	$2,136.75
HAMMARLUND	HQ-180A	1963	$439.00	$2,173.93
NATIONAL	HRO-50	1950	$349.00	$2,194.16
NATIONAL	HRO5AT1	1946	$300.00	$2,331.00
NATIONAL	HRO-60	1952	$483.50	$2,764.65
HALLICRAFTERS	SX-88	1954	$595.00	$3,351.04
Receivers for the Military				
HALLICRAFTERS	SX-73	1952	$975.00	$5,575.05
HAMMARLUND	SP-600	1950	$985.00	$6,192.70
COLLINS	51J-4	1952	$1,099.00	$6,284.08
COLLINS	R390-A	1958	$1,421.00	$7,448.90
COLLINS	51S-1	1959	$1,828.00	$9,518.40

DEALING WITH NOISE

Bob Eldridge VE7BS

The object of radio is to convey information from one place to another without wires. Some listeners may consider anything that interferes with this traffic to be 'noise', even though it may pass vital information to others. This article deals with the kinds of noise that nobody wants to hear.

Noise takes several forms, most of them dependent on the radio frequency. These include: atmospheric (mostly lightning and rain static); man-made (conducted/radiated hash and impulses like motors, dimmers, power lines); cosmic (hiss and thermal noise from distant space); and noise generated within the receiver (white noise, hum and distortion).

There are six primary ways to tackle noise: the filters in and between our ears; filters between the antenna and the detector; at the power line; audio filtering; grounding techniques, and optimum adjustment of the receiver.

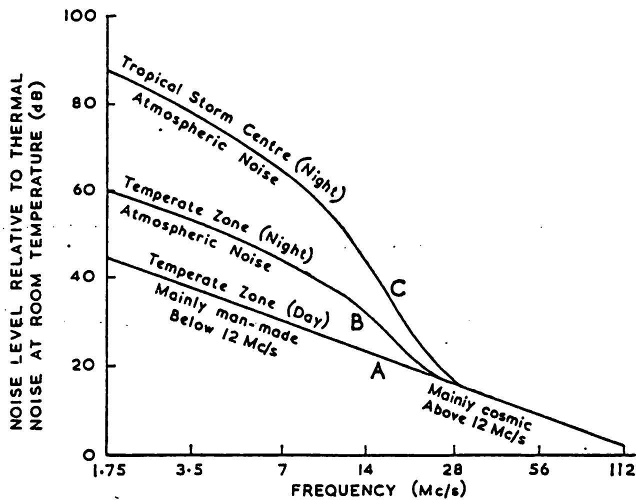


Fig. 15.6. Variation of external noise level with frequency. Curve A shows that during the day in temperate zones the noise is mainly man-made at frequencies above about 12 Mc/s. In these zones, atmospheric noise adds considerably to the total noise level at night (curve B). In tropical zones the atmospheric noise is relatively severe: curve C represents the worst conditions in these zones. The vertical scale indicates the number of decibels by which the noise level in a perfect receiver would increase if it were disconnected from a dummy aerial and fed from an efficient aerial of similar impedance.

Fig. 1. External Noise

THE FILTERS IN AND BETWEEN OUR EARS

The SWL listening post is a human-machine system. The human brain is the final receiving device, and everything else from the antenna through the receiver and peripheral devices to the ears is there to process the incoming information and make it more intelligible.

For the broadcast listener, pleasure and comfort are the primary aims, but for most SWLs the essential thing is INTELLIGIBILITY. Most of the time we are looking for the identity of a station, and the material of the program is of secondary interest. But the brain can be fatigued by noise and distortion, and the ears can be damaged by sudden loud crashes or clicks, so we have to provide for increased comfort as well. And of course, we do sometimes want to enjoy the program!

The ear has between 30 Hz and 20 kHz twentyfour audio sub-bands, within each of which a loud signal will 'mask' a weaker one[1]. The good news is that this enables a strong signal to mask weaker noise. The bad news is that noise can mask a weaker signal. Hence the importance of signal-to-noise ratio (more correctly expressed as 'signal to noise-plus-distortion ratio'). If the stronger signal is strong enough, the brain does not hear the weaker one within the same sub-band. At the lower end of the audio spectrum the sub-bands are of the order of 100 Hz wide, while at the upper end they are of the order of 2 kHz wide. This is one of the reasons why an operator can mentally separate two tones a given number of Hz apart when they are heterodyned to a lower part of the audio spectrum (listening to 300 Hz and 500 Hz rather than 1200 and 1400 for example).

Note that this 'masking' occurs only when one signal is stronger than the other. If the two signals are of equal strength the ear can separate two signals that are more than about 50 Hz apart. This explains why some morse code operators prefer to use a wide bandwidth filter and rely on the brain. Non-masking noise does not destroy the intelligibility of a signal, although it does introduce some stress.

The ear has a dynamic range of 100 dB or more (it can hear very quiet sounds and deal with very loud ones). It can hear the DIFFERENCE in the level of two sounds better if they are both quiet than if they are both loud. The sounds can be separated most easily if one is on the fringe of audibility and the other within the audible range. The telephone companies know this very well, so audio levels on the system are kept low enough to make hum and noise as unnoticeable as possible.

So what? Well, armed with this knowledge we know how to deal with each of two conditions:

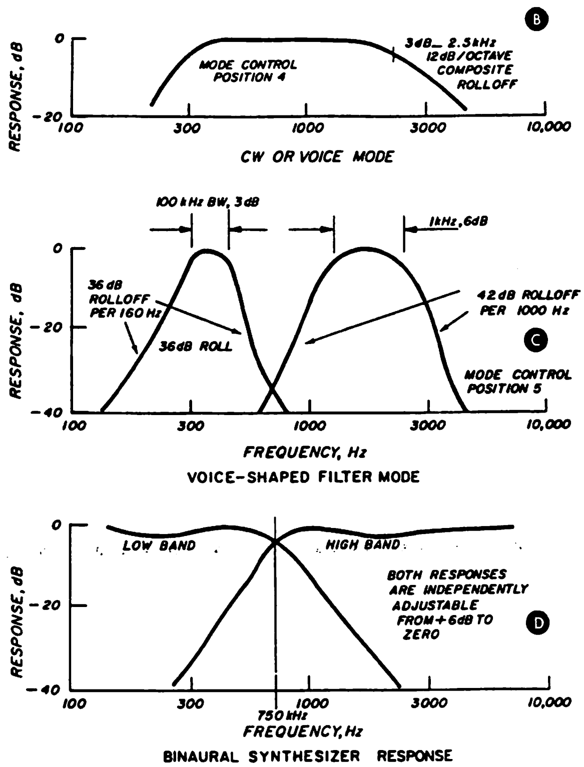


Fig. 2. Hildreth double peak filter

1. If the signal is stronger than the noise, turn down the volume until the noise is not troublesome.

2. If the noise is stronger than the signal, use a clipper to reduce the difference in strength, giving your brain a better chance to sort them out.

AUDIO FILTERING: SELECTIVE ATTENUATION

Best signal-to-noise ratio is obtained when the occupied bandwidth equals the necessary bandwidth. If the bandwidth of your filters is too wide, the amount of noise will be increased but not the signal. If the bandwidth is too narrow the signal will be reduced more rapidly than the noise. The necessary bandwidth does not have to accommodate all the frequencies produced by the human voice. You are seeking intelligibility not high fidelity.

Don Hildreth W6NRW produced a very effective 'Comm Audio Processor'[2] (CAP), based on the principle that almost all the necessary information in the voice is between 300 and 400 Hz (vowel sounds) and 1.5 and 2.5 kHz (intelligibility sounds). Anything below, above and between those bands does more harm than good.

The CAP takes the audio from the receiver, passes it through parallel 300-400 and 1500-2500 kHz filters (Figure 2), then through lowpass and highpass filters that split the audio at 750 Hz. The two signals are routed through separate adjustable-gain amplifiers to output terminals designed to feed loudspeakers or binaural headphones. I was fortunate to buy one before Don ceased production several years ago and it has been in daily use ever since. If you can find one, buy it.

One remarkable feature of the filter is that it makes grossly over-compressed speech sound quite reasonable. This is because much of the distortion caused by over-compression is in-band intermodulation appearing between the two humps of the filter combination. Because of the variable gain on each amplifier excessive bass or treble components of the voice can be compensated for (and it is surprising how often the bass end can be removed almost entirely without harming intelligibility). Because of the essential difference between stereo and binaural, it is sometimes possible to understand a voice better on speakers than on headphones. True stereo, and the "cocktail party effect" (the human ear/brain function that enables you to pick out the interesting conversation from the babble all around) depends on the ability of the ear and the brain to respond to differences in loudness, phase, and time of arrival of sounds. Sensing the apparent direction of arrival helps the brain separate the respective sounds. It seems complicated, but it is sure fun to experiment with it.

The CAP also incorporates a white noise generator (white noise is energy distributed evenly over the audio-frequency band, and is the hiss you should hear if you disconnect the antenna and turn up the gain with the receiver on wide bandwidth). White noise is used in offices to mask the tapping of typewriters and other distractions. It can be introduced into the receiver audio to replace a low level unpleasant noise with a designed level of white noise, or remove ringing from cascaded narrow filters, or mask the weak but audible and intelligible speech you don't want to get interested in. One has to be careful though, because the masking effect is greater when the masking frequency is the higher, and white noise is also used as an anesthetic and a sleep-inducer!

The principle of the Hildreth filter can be demonstrated quite well if you have a notch filter on your system. Just put a notch at about 1000 Hz in the middle of a noise-affected voice. If you have also a bandpass filter that attenuates below about 300 and above about 2000 Hz so much the better. An Autek QF1-A will do it quite well, except for the limitation to single channel output. Operation of the QF1-A can be improved by the addition of input and output level controls[4]. An excellent review of the QF1-A by Jerry Strawman appeared in *Proceedings 1988*[8].

An audio equalizer with sliders at 100, 300, 1000 and 3000 Hz will do a fair job, and several filters have been reviewed in past *Proceedings,* as listed in the bibliography.

If you are interested in listening primarily to voice, find a headset designed for voice frequencies. Guy Atkins bought a Roanwell aviation headset from Fair Radio Sales for $20 that he says is really outstanding for voice. I checked with Fair Radio in May 94 and they had no aviation headsets of any type left, but with defense cuts the way they are there will be more coming available. They are 600 ohms impedance, but Guy says they sound fine with his Drake R7 and R8. If you use phones of radically different impedance make sure the mismatch does not harm the intelligibility. Good reproduction is essential for this last link in the chain. If one of your ears is better than the other there is great merit in having a volume control on each earphone. The brain likes to get equal response from each ear.

AUDIO FILTERING: CLIPPING

An electric fence, a flashing electric sign, a succession of lightning discharges cause sharp spikes of noise to be superimposed on the audio. A clipper like that in Figure 3 may not work if it is connected across the low impedance of headphones or speaker. It may be necessary to step up the impedance to several hundred ohms as in Figure 4. The impedance ratio of the transformers is not important, but they should be designed to carry audio. You need something of the order of 600 ohms impedance across the clipper circuitry, taking care not to produce more audio voltage than the diodes or transistors can handle.

Germanium diodes are more useful than silicon, as they will pass current at a lower forward voltage. Figure 4 performs the same function as Figure 3 using a PNP and an NPN transistor self-powered from the audio. The spikes will still be present within the receiver, so use fast or no AGC to prevent the receiver from being paralyzed before the audio gets to the clipper.

The simple clippers shown here have to be used with caution, as hard clipping without compensating lowpass filters can produce distortion that is as damaging to intelligibility as the noise itself. There are many interesting series and/or parallel clipper circuits in the older receivers and this is a subject all to itself.

Digital signal processors are "in" as I write. The JPS NIR-10[6] was the first on the market. It is excellent for removing heterodynes and white noise, and has very sharp bandpass filters, but like all digital signal processors it has to have an intelligible signal to work on, so cannot dig an unreadable one out of noise. Revision 3.0 PROMS provide a

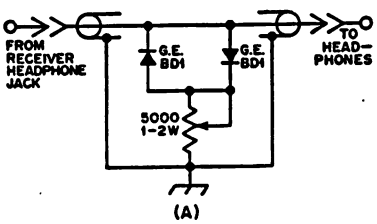


Fig. 3. audio clipper for high impedance input

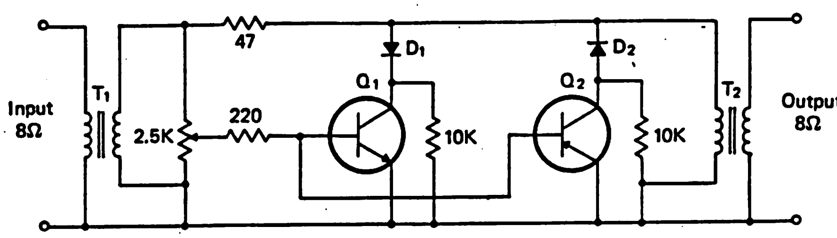


Fig. 4. audio clipper for low impedance input

useful automatically adjustable bandwidth feature, whereby the processor dynamically varies the bandwidth to fit the width of the desired signal. JPS provides new PROMS for $25, easily fitted into sockets. There are PROMS specifically for SWL use.

Several other DSP units have come on the market, including a very versatile one from MFJ and a barebones one from Radio Shack. A potential user would be wise to look carefully at the features of all of them before deciding which to buy.

FILTERING BEFORE THE DETECTOR

A built-in noise blanker senses noise pulses at a wideband point in the receiver, turns them upside down, and reintroduces them to the signal to cancel out the pulse or even punch a hole in the audio. A hole is less disturbing than a spike both to the later stages in the receiver and to the ear.

If you have a variable control for the blanker, don't advance it more than you have to or you may hear some noises-off from strong signals right outside the normal selectivity passband.

Blanking somewhere before the detector is much better than clipping at the audio level, because it removes the pulses before they have a chance to upset the AGC action or drive the detector into distortion. R-f and i-f bandpass filters have the same advantage. If the noise can be prevented from reaching the detector, it cannot affect the purity of the demodulation or the action of the AGC. The problem for the designer is that it is more difficult to achieve a precise shape of the bandpass curve in the higher frequency stages.

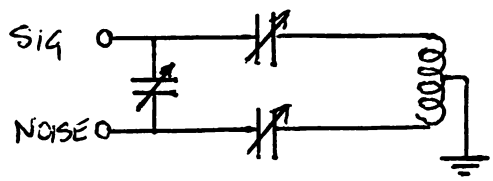


Fig. 5: Jones Circuit

ANTIPHASING AT THE ANTENNA TERMINAL

The most troublesome noise is usually that from the power lines. If you can pick it up on a separate antenna and feed it to a device that inverts the phase, noise can sometimes be cancelled before it ever reaches the receiver. The 'Jones noise-balancing circuit' Figure 5 was popular many years ago, but was not easy to adjust.

A much better antiphaser is the 'S.E.M. QRM Eliminator' that I reviewed in the *1992/93 Proceedings*[7] and still have in use. It works fine for me, but a friend in Vancouver found it was of no use at all in his downtown location. He relies on a small rotatable directional loop, pointing the null at the main source of the noise.

GROUNDING

Nick Hall-Patch covered this well in the *1992/93 Proceedings*[9], so I will only add a note about the possibilities of Bentonite. This is a water-attracting clay material that swells dramatically when wet. You drill a hole of much greater diameter than your ground rod, suspend the rod in the middle of it, backfill with Bentonite and pour on lots of water. The Bentonite swells and swells, gripping the rod tightly, assuring continuous contact with the rod and with the surrounding earth. It continues to attract any moisture that is around, so stays tight. A Bentonite product especially for ground enhancement is GEM-25A, produced by Erico Inc.[5].

Bentonite is a natural product, used widely as a slurry for well drilling, and also for sealing basement walls against moisture and lining water reservoirs. A good supply source is a welldriller supplies store. I am told it is not itself very conductive, so has to be mixed with something that is, to reduce the resistance of the ground connection.

As Nick commented, sometimes connecting the receiver to ground actually introduces noise. If noise is being conducted to ground from the utility neutral to the utility ground stake, the ground around it will have gradients of noise voltage. If an r-f grounding system intercepts some of those gradients, the noise may be heard in the receiver. The r-f ground should be as far from the utility ground as practicable.

POWER LINE NOISE

Much of the noise conducted or radiated by the power line is generated on the premises of power utility customers, and usually the best you can do about it is be sure it is not coming from within your own house!

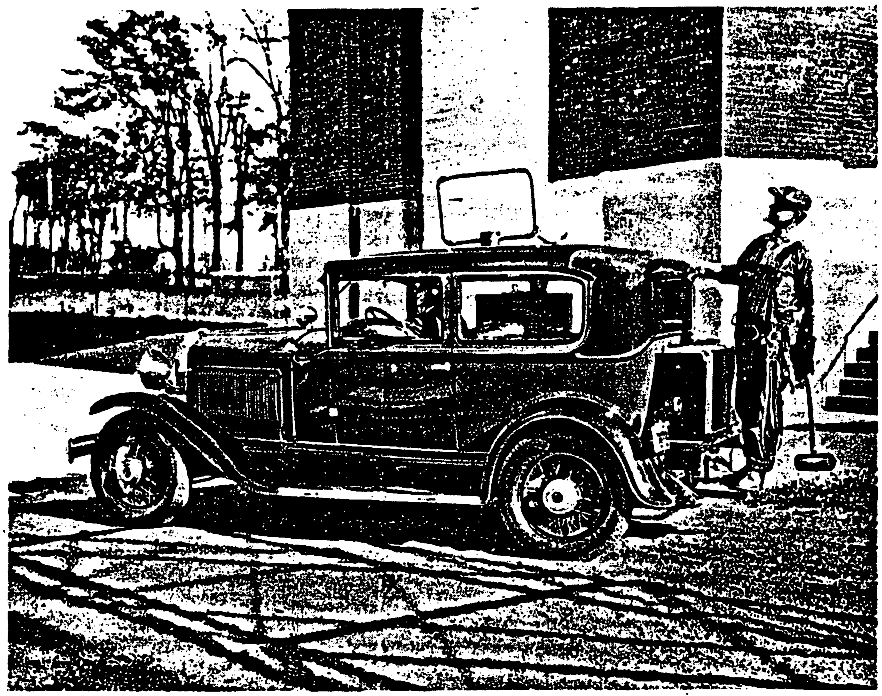
Sometimes the local distribution line (the single 7000, 14000 volts or more conductor carried at the top of the pole line) is the culprit. Frying noises from loose connections and tie points, irregular ticks and pops from loose pole hardware, raspy buzzing from faulty insulators, often quieter when the weather is wet. Expansion and contraction of wooden poles with climatic changes loosens things up, and power companies seldom go round tightening them unless someone complains about the noise.

If the noise is loud at the end of the line, it may not be originating there. A standing wave of noise may occur, and peaks and nulls will occur along the line. As you approach the source of the noise the peaks and nulls become less pronounced but the noise gets louder. You can often trace the noise to an offending pole by walking around with a portable radio, or even driving around in the car. Bonk the pole with a sledgehammer. If the noise changes immediately you probably have the pole. If there is a delayed reaction it is probably another pole. The experienced bonker gets to be able to estimate how far away the trouble is (and doesn't mention that he has been bonking).

About twenty years ago a ferric oxide semi-conducting glaze was developed for insulators, and found to produce no r-f interference on NEMA Class 56-3 pin-type insulators after a year of exposure on 44 kV line. The cost of these insulators is about the same as that of normal Q-glaze, but I have no idea how many have been put into use or where.

The grounding wire that comes down the pole and is wrapped around under the ground may not be in good contact with the ground. IT IS DANGEROUS, and is something the power company will fix in a hurry. While there the workers may be persuaded to check and tighten other things, especially if you can show them the interference affects broadcasting. Broadcasting is much more important than short wave or amateur radio.

A lot of noise is conducted into the receiver along the power cord, and ferrite beads or snap-on ferrite chokes are often useful. Or the power cord can be wound around a ferrite rod. I found there was some noise radiated from the keyboard of my computer, and to my surprise a ferrite rod slipped inside the coils of the coiled connector cord reduced it quite a lot. I don't know whether the noise is generated within the keyboard or conducted to it, but the rod fixed it and I settled for that.



Government Car equipped for the Investigation of Radio Inductive Interference.

OPTIMUM ADJUSTMENT OF THE RECEIVER

"What is the best setting for the r-f gain control?" Turn down the r-f gain until you can just hear 'band noise' in the absence of a signal. When you tune for a signal ANYTHING THAT IS STRONGER THAN THE NOISE WILL BE AUDIBLE.

If your automatic gain control (AGC) is audio-derived, and your receiver uses a product detector, this advice is 100% valid. If it is derived from a diode detector, as in most of the older receivers, some experimenting is necessary to find the best r-f gain setting for each type of signal. This is because when you are using a beat frequency oscillator (BFO) and a diode detector the ratio between the signal strength and BFO injection is important. With a product detector there is a lot more latitude.

An aside: about 30 years ago I bought a Drake 2B receiver. It has a slide switch to select either diode or product detector. After the first comparison between the two, the diode position was never used again. Listening to short wave AM broadcasting stations became so much more pleasant when we could select either the upper or lower sideband and reinsert a carrier. There are theoretical disadvantages to this - the audio is reduced by 6 dB and the noise by 3 dB when one sideband is removed. But the absence of selective fading distortion and sometimes removal of interference affecting only one sideband compensates. Whether your receiver is superb, average or poor, you can improve signal-to-noise ratio just by careful adjustment of the controls. Noise generated within the receiver is a fact of life, and for best reception the gain at various points within the set has to be 'balanced'. When you are struggling to hear a very weak signal every little step towards perfection helps.

The manufacturer of the receiver does not know how sensitive your headphones are, so there may be more gain than you need in the audio amplifier. Turn the audio volume control almost to zero (not quite against the counterclockwise stop). If you hear the gentlest of hiss, everything is fine. If you hear some hum or hash you should try to do something about it, knowing the trouble is in the audio stages or the power supply. If you hear more than a smidgeon of hiss, consider putting some attenuation between the output stage and the headphones - a series resistor may be all you need. If you have a volume control on each earphone, turn them down until you only just hear the hiss. If one of your ears is better than the other, adjust the two controls individually. This is quite important, as your brain always prefers two ears rather than one. The threshold of inaudibility is about 10 dB lower if you are listening with both ears.

If you are using an active filter unit between the set and the phones, make sure it is not contributing any hiss or hum in the absence of signal. One filter I have is specified as requiring 12-15V to operate. I noticed I could hear some background hiss when the receiver was switched off. I found that the filter unit was quiet when fed with only 9 volts and operation was as good as with 12 (in fact I believe it now has some accidental gain compression because of earlier saturation, which is welcome). Reducing the voltage was easier than introducing some attenuation.

In modern receivers the so-called r-f gain actually controls the gain of the intermediate-frequency stages. In older receivers it usually controls both i-f and r-f stages. By manipulation of this knob you have control over the amplification contributed by the i-f department. This is a very important part of the set as far as noise is concerned, because any noise generated there is passed on to the detector (where the demodulation process gives it the best chance of disrupting the desired signal) and is then further amplified by the later stages. Sometimes the effectiveness of i-f filters or the noise blanker is affected by the gain. Setting the r-f gain control so that 'band noise' is just audible is almost always the right place for it, and this also ensures that you will not hear surges of noise when the signal fades. When you find a signal adjust the audio control for comfortable level. Then if the signal is marginal you can jockey the two controls up and down a little for best signal to noise ratio.

I don't know why it is, but on one of my receivers there is usually one setting of the audio volume control that gives best intelligibility, often resulting in a lower volume than I would choose if the signal were 'armchair copy'. If you want an S-meter reading you probably have to advance the r-f gain control temporarily, and the signal may very well change from Readability 5 Strength 3 to Readability 3 Strength 9.

On a receiver that has r-f derived (as opposed to audio derived) AGC, a useful trick is to turn down the r-f gain control until the S-meter reading stays constant at the peak level of the signal. Turning down the gain introduces the same kind of negative bias as that produced by the AGC circuit, preventing noise from welling up when the signal fades down. I knew one SWL who did this all the time as a routine, and we seldom found a better setting on his receiver, which I believe was an HQ-129.

If noise coming in from the antenna is really bad, and you have an r-f attenuator switch, it is probably a good idea to use it, to prevent overloading of the first mixer. If more than one signal is getting into the front end, introducing 10 dB of attenuation will reduce any cross-modulation or intermodulation by more than 10 dB.

Noise power is related to bandwidth, so anything that provides selectivity in front of the receiver, like a sharply tuned antenna or an antenna coupler with a bandpass characteristic, will help. Some hash coming from the power line or fluorescent lamps centers on one part of the r-f spectrum, so a selective filter in front of the receiver will be especially effective for rejecting it.

For good reception your receiver sensitivity must be 'noise-limited', which means simply that noise generated within the receiver must be low compared with that picked up by the antenna. A simple test will show whether this condition is met. Set up your receiver for normal operation with medium or wide bandwidth and tune to a spot where there is no signal. Measure the 'band noise' at the audio output with a VOM using an a-c voltage range that gives a reading well up on the scale. Remove the antenna and replace it with a resistor (50/75 ohms or so if your receiver is designed for coaxial cable input, 400 ohms or so if designed for single wire antenna). The reading should drop to a lower level. A 6 dB drop on a quiet band (half the former voltage) is excellent.

Of course the difference will depend on how much noise is being picked up by the antenna, and one thing the test makes clear is that if you have lots of local noise you don't need a sensitive receiver. Sensitivity probably varies from one band to another, and this makes sense, because so does the average noise level. See Figure 1.

CONCLUSION

Every location is different, receivers vary widely, and your particular needs may be unique. If you find something new to think about here, that's good. If you find it so-so, congratulations! You have already solved the problem.

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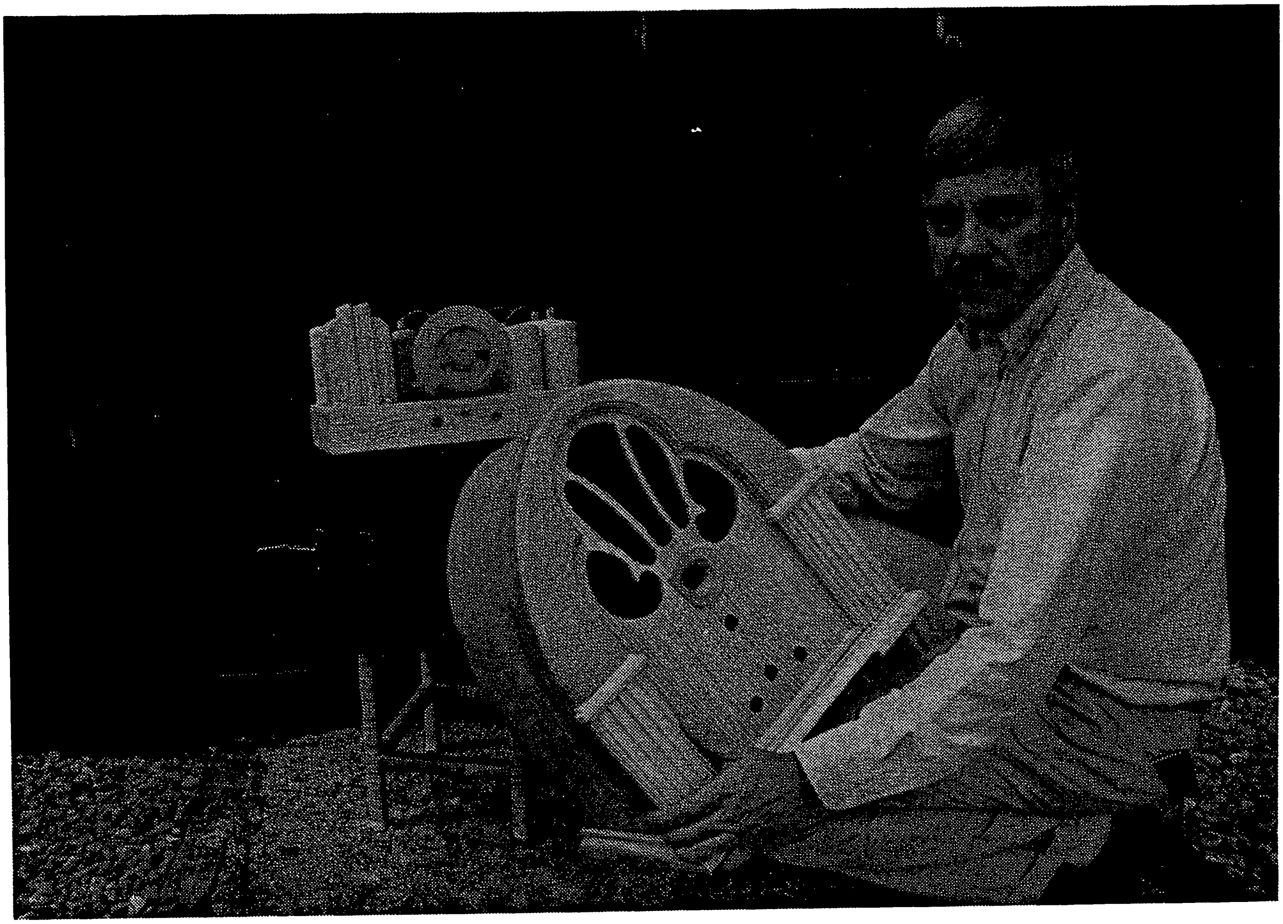
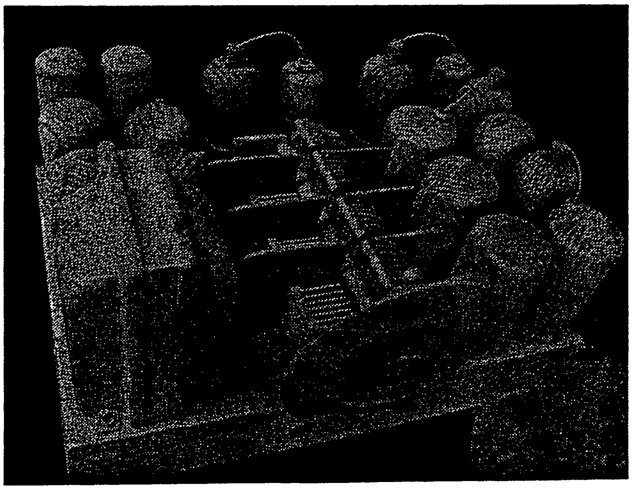
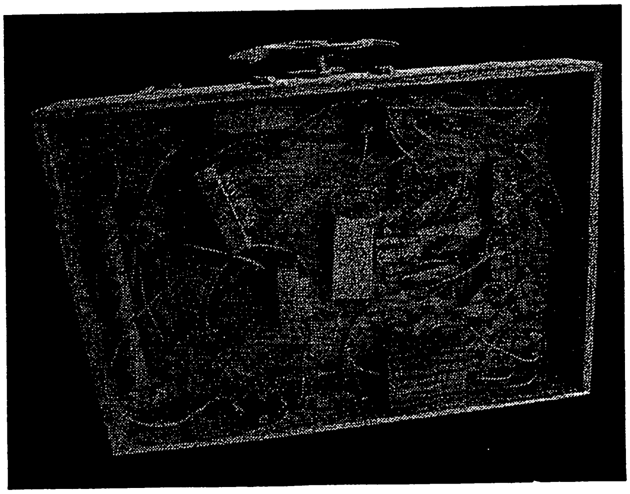
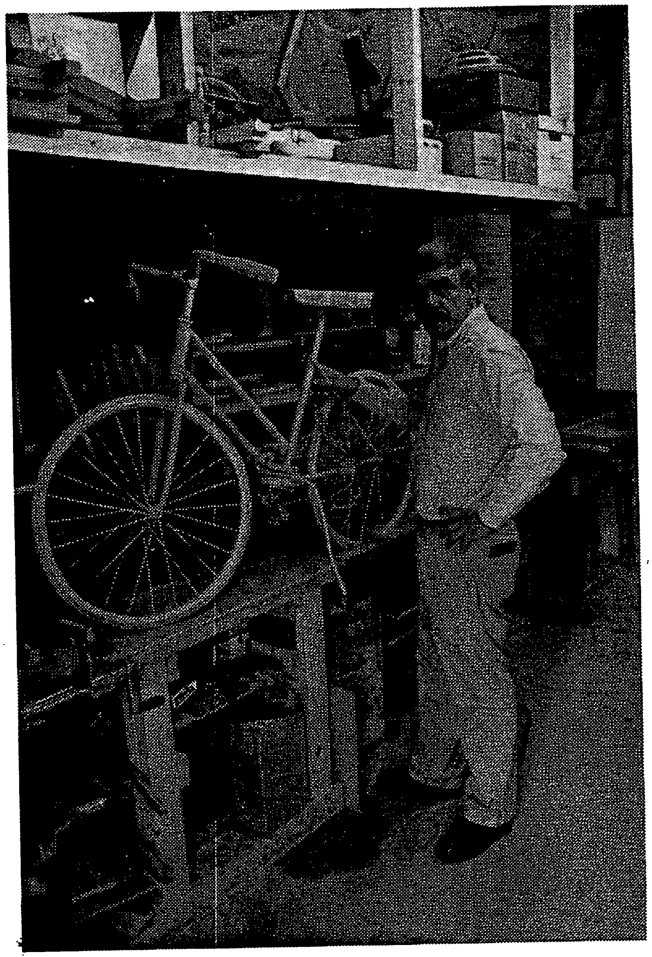
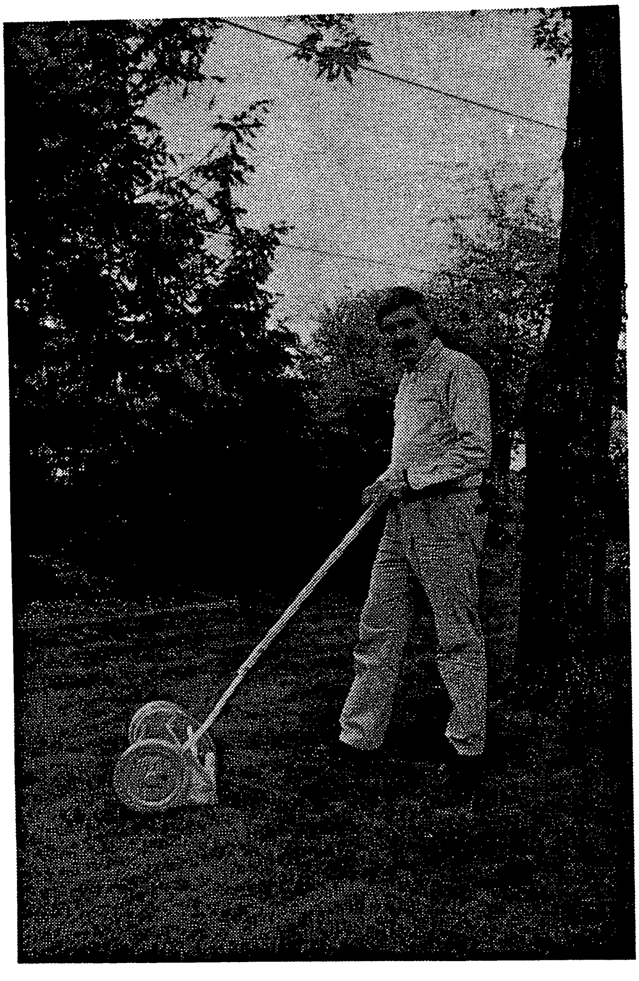
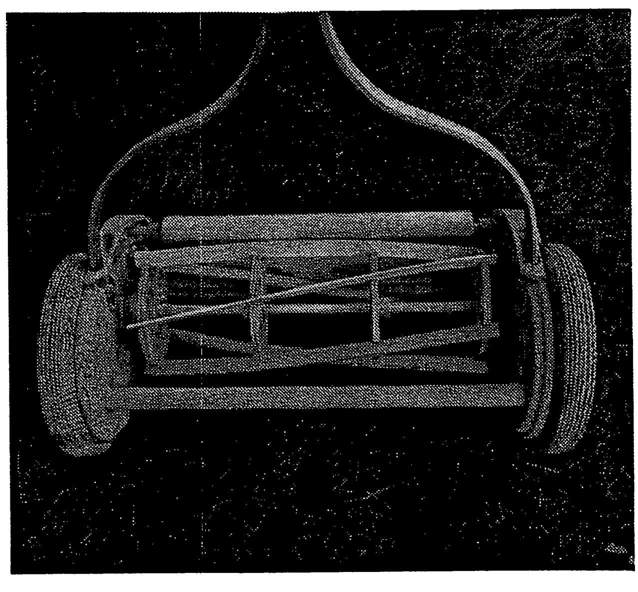
OUR RESIDENT SCULPTOR: FRITZ MELLBERG







As you probably know, a good deal of the clarity of style of each of the editions of *Proceedings* is due to the diligence and editorial talent of Fritz Mellberg. Until recently, not even the rest of the *Proceedings* Staff knew of Fritz' talent as an artist-sculptor in wood. The photographs on these two pages do not begin to do justice to the beauty of Fritz' creations. Fritz has combined his interests in art, woodworking and radio in the pieces shown above. All parts of each piece shown are sculpted from wood and all are left in their unfinished state. The wiring in the Philco cathedral set above was made from steamed rattan. Most of the rest of the radio is white pine. And, yes, the tuning capacitor moves!

This set was originally part of a tableau arrangement of the Philco chassis and cabinet, sitting on a Fritz-designed wooden table and accompanied by a Fritz-designed wooden soldering iron and wooden goose-necked lamp. The tableau was titled "Fixing a Philco." The second set of photos record an all-wooden full-sized push lawnmower and a full-sized ladies bicycle. Note the springs under the bicycle seat, the security chain and the sprocket and drive chain. Each is authentic to the last detail. Fritz has exhibited his pieces and they have been published in magazines and newspapers.

YOUR FIRST 50 TRANS-ATLANTIC COUNTRIES ON MEDIUM WAVE

(And Then Some)

Mark Connelly, WA1ION

Anyone who has been following the news over the past twelve years will realize the great degree of change to the political landscape of Europe, largely related to the break-up of the former Soviet Union, the continuing turmoil within the former "Eastern Bloc" countries, and the re-unification of Germany. Africa, too, has been changing. These changes have had a profound influence on broadcasting. Technology, including increased use of FM and digital broadcasting techniques, is shaking things up on the old medium-wave AM band as well. Large stations like Langenberg, Germany (1593) leaving AM in favor of FM may be providing better audio locally, but they do a disservice to more distant listeners. FM can seldom provide nationwide coverage, let alone continent-wide or global reception.

The intention of this article is to assist experienced DXers in preparing themselves to tackle the challenges of DXing the medium wave broadcast band for Trans-Atlantic (TA) signals. It provides the DXer with an updated list of countries in approximate order of reception ease, along with information about best reception frequencies and times. Propagation analysis strategies are also brought into play. Much has been learned from the 1991 and 1993 Newfoundland DXpeditions and from continued monitoring by DXers in eastern Canada (Burnell), New England (Conti, Connelly), New Jersey (Straus), Pennsylvania (Dangerfield), and many others. The South Florida DX Club (Seiden, Crawford, Scotka, et al) has provided insights to MW DX from that TA-viable area. All of these new loggings build upon a bedrock of DX knowledge running back to the work of Nelson, Bailey, and others in the 1960's and earlier.

As most medium wave TA DX is reported by those living in the northeastern USA and eastern Canada, the reception notes have been formulated with this area in mind. Midwestern (Great Lakes Area), Southern (FL, GA, TX, etc.), and Northwestern (OR, WA, BC, etc.) DXers also hear the TAs. Many of the reception notes in this article will be of use to listeners in these areas, but differences do exist. This is especially true with regard to East Coast sunset DXing information which is not applicable to those farther west. Of course, Brian Vernon's loggings from Yukon and the Northwest Territories are a separate TA (more correctly, Trans-Polar) DX case. A strategy for these far-northern Canadian sites would bear little resemblance to that for any DXer in the lower 48 United States, except (perhaps) the Pacific Northwest where auroral "doughnut hole" receptions of high-latitude Russians and Scandinavians can occur with Beverage aerials under prime conditions.

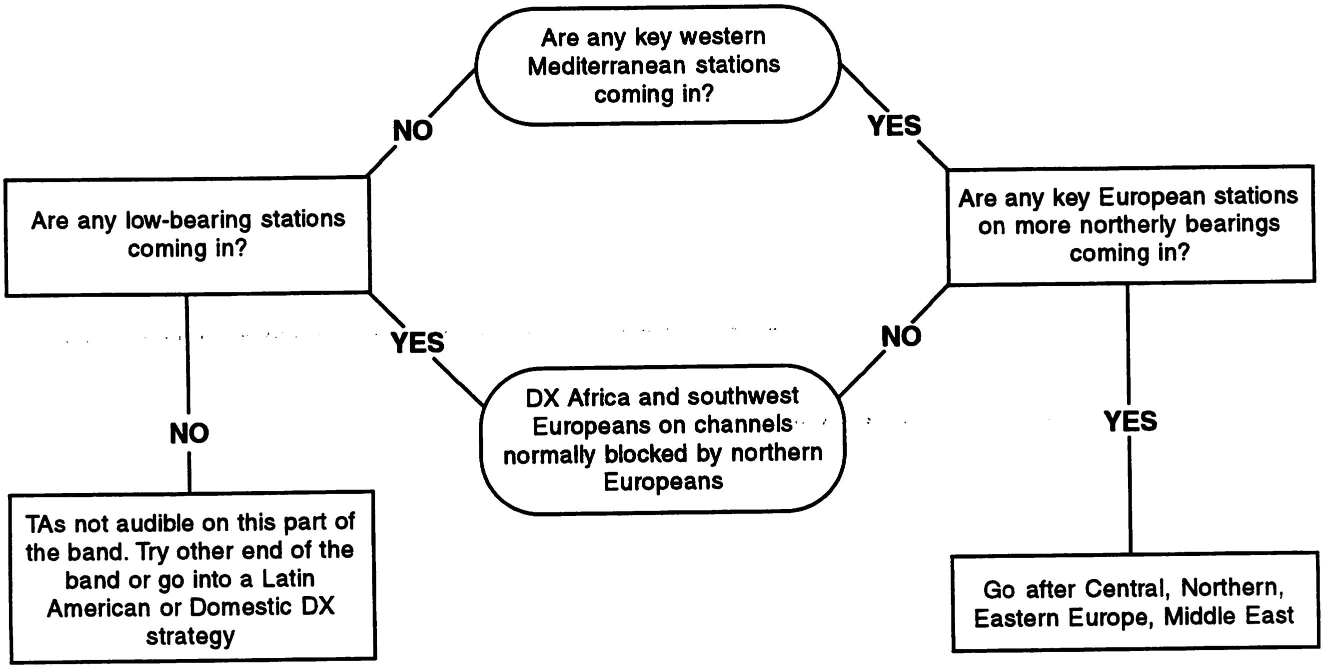
As a preface, the prospective medium wave TA DXer should have access to worldwide sunrise/sunset tables, a copy of the latest *World Radio-TV Handbook* (*WRTH*), and a suitable receiver. The receiver and antenna required to hear TA's is dictated largely by the listener's location. Armed with no more than a car radio with whip antenna or an unaided Sony '2010 or Realistic TRF, a DXer will have no trouble pulling scores of TA's if he's at Waterfront Park in Boston at sunset in autumn and winter. Even if it's auroral, some of the high-powered Africans should be audible. For those not lucky enough to be at a perfect site with ocean towards Europe/Africa and obstruction towards most domestics, better receivers and antennas will be required. A good communications receiver with tight filters (e.g. R390A, Drake R8, NRD 535, HQ-180A) and an amplified high-Q tuned air core or ferrite loop, possibly augmented by phased longwires or Beverages, will definitely help you haul in more TA's, regardless of your location. Lesser receivers can be "perked up" by using a regenerative preselector such as the MWT-3 or by using a loop such as the Kiwa or Martens having regeneration capabilities built in. Memories, accurate readout, and synchronous AM detection/ECSS are tipping the scales towards a preference for modern equipment over the tube dinosaurs - especially now that the newer receivers have gotten good enough to compete in hand-to-hand combat with the old Hammarlund, Collins, National, and Hallicrafters sets in basic reception quality (sensitivity, selectivity, and freedom from spurious responses). During a good opening, and especially on a Beverage DXpedition, frequency-hopping agility and the ability to blast through stored parallel channels and propagation-indicator stations can make a big difference. It is unlikely that we would have logged 92 countries on MW from Newfoundland over a long weekend if the team was limited to using 1950's-technology receivers.

The reader is advised to consult the NRC and IRCA reprints lists for excellent receiver reviews and tests by Gerry Thomas, Dallas Lankford and others. Larry Magne is a noted reviewer of receivers; his work has appeared in the *World Radio-TV Handbook*.

Inexperienced DXers should carefully hone their split station tuning skills by practicing on powerful Pan-American splits such as Turks & Caicos - 535 and St. Kitts/Nevis - 895. Keep tables of TV "birdie" frequencies and Latin American splits at hand. Not all non-10 kHz channel signals are from across the Atlantic.

The quickest way to ascertain whether TA DX possibilities exist is to check several frequencies known to have strong signals under even mediocre, let alone good, conditions. The stations checked should be distributed evenly between low- and high-band frequencies, and between lower and higher latitude bearings. Actual stations checked may differ as a function of time.

A working TA DX strategy is outlined by the following block diagram and tables of key stations:



When using the above TA-hunting strategy, you must keep station operating schedules in mind. Consult the *WRTH* and the country-by-country breakdown to follow. The concepts presented in the previous strategy may someday find application when computer-controllable receivers (with programs making decisions based upon signals found and not found) become common.

Most experienced medium wave TA DXers have evolved one or more working schemes, possibly similar to the above. Occasionally, a departure from standard TA hunting schemes in favor of a complete bandscan, or search for split frequency station caused heterodynes from the bottom of the dial to the top, is advisable.

Key stations to use in the "decision blocks" of the strategy diagram are shown on the facing page.

Check WWV (2.5, 5, 10, 15, or 20 MHz) at 18 minutes past the hour from time to time to keep abreast of the A and K index information. Some DXers have found that keeping track of these numbers has helped to give their DX activities a sense of direction and also helped them correlate these indices of geomagnetic activity with real life TA DX propagation patterns. The A index (Afr: A index, Fredericksburg, VA) is that most commonly mentioned in DX circles. It ranges from 0 to over 100. Favorable high latitude TA DX conditions are associated with several consecutive days of low geomagnetic activity (A indices less than 6). Disturbed conditions are indicated by somewhat higher A numbers. Often such conditions produce short skip and/or semi-auroral conditions with low-band receptions limited to the western Mediterranean region of Europe (Spain, Portugal, southern France) and Africa. Higher latitude stations may still get through on frequencies above 1400 kHz. Such stations (e.g. 1539) often exhibit fast flutter type fading. Really auroral conditions occur with high geomagnetic activity (caused by solar disturbances) when the A index soars above 20. The only TA's likely to be heard are Africans well to the south of the Mediterranean coast countries, so check those listed above as "low bearing Africans".

During a heavy aurora, it's best to concentrate on Caribbean and South American DX. The really choice Africans are generally only heard with Beverages at the beach, preferably from outer Cape Cod or Maritime Canada. Such aerials should be over 400 meters long, aimed at 105 degrees plus or minus 10 degrees bearing away from the DX shack. There are some exceptions: Lesotho - 1197 (one of the few high-band far-south Africans running serious power) is often loggable on a ferrite loop during a good aurora from the Granite Pier DXpedition site in Rockport, MA. Sao Tome -1530 and certain Angolans are loop-receivable at that site as well.

I have found that a loose correspondence between the A indices and real life propagation exists and obtaining these numbers provides an interesting supplement to DX information. However, you should always check key stations using TA strategy similar to that outlined earlier in this article. Never write off a potential DX session before checking actual MW conditions, just because the WWV propagation alert sounds discouraging.

Autumn and winter provide the best TA DX, but some TA's can be heard year-round. Morocco - 1044, Algeria - 891, and numerous Spaniards come to mind. Spring and summer can provide unique opportunities, especially with regard to high-band Iberian peninsula stations. These stations remain in darkness well after the summer sun has risen at co-channel transmitter sites in more northerly countries, such as Germany. Subequatorial Africans have been received in May, a month not generally considered good for DX. Historically, late August through early April has been thought of as the TA DX season. Late September through early January is usually the best part, as the "midwinter anomaly" (thought to be related to the effects of lower ionospheric temperatures) slows things down a bit in the latter part of winter. Around the winter solstice and Christmas, one can profit from the fact that darkness lingers longer in northern Europe than in the Mediterranean, as Algeria - 549 enters daylight and fades, the German on that channel is left in the clear long enough to get reception report details or a good tape recording. A brief sunrise/sunset chart is included as an appendix to this article. More elaborate forms (both map and tabular) are available as NRC and IRCA reprints.

KEY STATIONS: TA DX STRATEGY	
Low Band (500-1000 kHz)	
Western Mediterranean Region:	
Algeria	549, 891, 981
Spain	585, 639, 684, 738, 774, 873, 954, 999
Portugal	666
Morocco	612, 711
France	675, 945
Italy	846
Low-bearing African:	
Canary Islands	621, 837
Senegal	765
Higher-bearing European:	
UK	693, 882, 909
Germany	756
Holland	747
Switzerland	765
High Band (1000-1700 kHz)	
Western Mediterranean Region:	
Algeria	1422, 1544
Spain	1107, 1134, 1359, 1584
Portugal	1035
Morocco	1044, 1053
Albania	1395
France (Monaco)	1467
Malta/France	1557
Tunisia/Azores	1566
Vatican	1530
Italy	1332
Low-bearing African:	
Canary Islands	1008, 1098, 1179
Mauritania	1349
Angola	1088, 1115, 1367
Lesotho	1197
Sao Tome	1530
Higher-bearing European and Middle East:	
Norway	1314
UK	1053, 1089, 1215, 1548
Germany	1017, 1269, 1422, 1539
Saudi Arabia	1512, 1521
Slovakia	1098
Denmark	1062
Russia	1386
Sweden	1179
Egypt	1107
Turkey	1017

ID'ING STATIONS

Stations broadcasting in English, of course, present no problem. Unfortunately, such stations represent a very small piece of the Trans-Atlantic DX pie. In regards to non-English language stations, the frequency and the language certainly get you a long way, at least toward a tentative ID. Use shortwave broadcasts to get accustomed to the sound and some of the rudimentary vocabulary of a number of languages from the three major European groups: Germanic, Romance, and Balto-Slavic. If the station is the only one on the channel listed with the language heard, if it has been reported by other DXers in your area, and you hear other stations close in terms of frequency and location to the station in question, you can pretty much log the catch with about 90% certainty. That other 10% of doubt can be removed with reception of a formal ID (generally heard at the top of the hour). These can be an interval signal (some are very distinctive), or in the case of rare commercial stations, advertisements mentioning local cities or brand names peculiar to one country. One must dig for as much identification material as possible, especially if you can't recognize the language being used or if several different countries are on the channel with the same language or similar sounding languages. Stations such as Vatican City, the Albanians, and Radio Sweden may run many different languages within a short time span. Furthermore, what one heard on one of these outlets at a given time one evening may be replaced by programming in a different language at the same time the following night. Format (e.g. rock music or religion), or cities and people mentioned on news broadcasts are supplementary pieces of information which may help to resolve an ID. Parallel frequencies, both medium-wave and shortwave, are great ways to nail down a conclusive ID. The Newfoundland DXpedition reports and regular international column loggings provide much information on parallel frequencies.

Other DXers may be able to dissect information from a tape that, to the original recipient of the signal, sounds like gobbledygook. Tape can be run through analog and digital audio filtering/processing to separate "the wheat from the chaff". Taping of RF (a swath of the band) using a video recorder, a method pioneered by Craig Healy, should emerge as a DX tool of immense benefit if the bugs can be worked out. Imagine scooping up the band as received on a beach Beverage pointed at Africa during a high aurora and having unlimited time to scan over the (4 or 6) hour tape later with your VCR output connected through a tunable preselector to your receiver input! The increasing availability of moderate-cost high-speed digitizers and high-volume disk drives may allow storage of an appreciable-length record of the entire MW band. This could later be digitally-processed to reduce pest-station slop, etc. before returning the stored signals to the analog (RF or detected-audio) world for the DXer.

In the early '70s, a peak period in terms of scientific DXing, DX bulletins published the EBU List with precise frequency measurements and drift data on TA stations. Precision Frequency Measurements (PFM) and Sub-Audible Heterodyne (SAH) analysis techniques were briefly in vogue as additional tools to ID TA's. Gordon Nelson, Ron Schatz, and others went into great detail on such methods. Broadcasters have, in general, made improvements to frequency control that lessen the degree of characteristic frequency "signatures". PFM and SAH analysis as identification tools have, therefore, largely fallen by the wayside. Loop direction-finding may also help, once a DXer has accurately prepared a bearing chart by using both a compass (and/or solar position) and nulls of known TA, LA, and domestic stations locations on a number of frequencies throughout the band. The known-station nulls calibrate out errors due to loop imbalance, nearby metal objects, power-line/wire-antenna reradiation and the like.

TA stations heard, even routine ones, should be reported to the two principal international DX columns. What somebody in Massachusetts or on Long Island thinks of as routine, is probably a good catch in the Midwest. To stimulate DX from sections of the U.S. and Canada away from the prime East Coast sites and to aid in the study of propagation patterns, report all TA's. For those "into" propagation study, the emergence of the home computer has helped to take much of the dirty work out of such studies.

In the list to follow it should be noted that station schedules change, so sign-on and sign-off times are only occasionally given. All times given are in UTC (GMT). Recent DX bulletins, the latest *WRTH*, local sunset, and European/African sunrise charts should be consulted to determine likely times of fade-in, sign-on, sign-off, and fade-out for specific stations.

This list represents fifty selected Trans-Atlantic countries, in approximate order of ease of reception (from Massachusetts). It is based on frequent listening at times evenly distributed between local sunset and transmitter sunrise. (Frequent listening means a daily average of 30 minutes DXing time.)

Note: St. Pierre and Miquelon-1375 is not considered a TA for the purposes of this article.

CATEGORY A: VERY EASY

SPAIN: Spain is on a southerly bearing and is, therefore, less subject to auroral blanketing than stations from northern Europe. Spain has many high-powered, largely split-frequency stations for the new DXer to hear with unsophisticated gear. These stations (mostly government RTVE-RNE outlets) help to tip off experienced DXers to the possibility of receiving the scores of lower-powered private stations in Spain. The high-power channels include 585, 603, 639, 684, 729, 738, 774, 792, 855, 954, 999, 1107, 1134, 1152, and 1359 kHz. Several others are also good, especially at shore sites just after sunset. Local channels, especially 1314, 1413, 1476, 1485, 1503, 1539, 1575, 1584, and 1602 kHz have also provided good DX opportunities. All stations program in Spanish, and music may be either pop or classical. Most are 24-hour operations.

ALGERIA: Algiers on 891 kHz is often the strongest TA signal heard in the northeastern states. It is present even during mediocre openings. Therefore, it's a good propagation beacon. Best reception is from one-half hour before local sunset to an hour after sunset. Domestic QRM is at a minimum during this period. Even later in the evening, this station gives WLS a run for its money, heterodyning strongly with it, and on better nights, completely swamping it out. In this case, WLS becomes the het. In such cases, a portable or car radio does fine. Programming on 891 is primarily Arabic music and talk. A few times French has been noted. Other Algerians are frequently noted on 531 and 549 (often parallel to 891). 576, 981, 1422, and others are also occasionally reported. The Algerians are usually heard running all night schedules. The clandestine station on 1544, once thought to be in the West Sahara area south of Morocco, is in Tindouf, Algeria according to the EBU monitors. It is very strong at sunset along the immediate coastline from Florida to Newfoundland, but doesn't seem to have much thrust inland.

MOROCCO: Sebaa-Aioun on 1044 kHz with mostly Arabic (but sometimes French) programming is reported fairly often, occasionally mixing with co-channel Spain and others. Parallel 1053 can come in well, giving BBC a challenge on that channel. Arabic talk and music often boom through on 612, 702, 711, 819, and 828 kHz. Moroccans are heard best at sunset from coastal sites in the northeastern states and the Canadian Maritimes; those in interior areas will do better around 0500 UTC "dawn enhancement". I've logged 1044 from El Paso, TX on a Sony ICF-2010 and small loop and Neil Kazaross has heard it in California. Moroccans noted less frequently are 594, 864, 936, 1080, 1188, 1197, 1233, and 1325 kHz.

CANARY ISLANDS: Santa Cruz de Tenerife on 621 kHz is present most nights. Its southerly route allows reception even when Spain and Portugal are "aurora'ed out". Other Canaries stations on 837 (mixed with Azores), 882 (mixed with UK), 1008 (with Holland and Spain), 1098 (with the Slovak Republic station), and 1179 (usually atop Sweden) are all solid possibilities. These are consistent performers here in the Boston area around sunset; many also do well at transmitter-site dawn. Theoretically, reception is possible during the entire period of mutual receiver/transmitter darkness; domestic interference considerations, however, point to sunset at the North American receiving site as the best reception time. Conditions conducive to African stations from Senegal (765) and Burkina Faso (747) should bring the Canaries stations in with little competition from Europeans. All of the other Canary Islands stations listed in the *WRTH* (e.g. 720, 747, 1269) should be possible under these conditions as this path is relatively low-loss.

SENEGAL: Dakar on 765 kHz is among the most consistent TA signals, largely due to its very southerly TA bearing (104 degrees from Massachusetts). Auroral conditions that totally wipe out European reception and severely attenuate Mediterranean-area North African stations frequently leave Dakar unscathed. In fact, a moderate aurora sometimes provides enhancement of 765, in terms of real strength as well as in terms of improved readability due to reduced QRM. This station is generally off the air from 0100 to 0600, although this may vary somewhat. The local sunset period is especially good at coastal locations. The transmitter sunrise period is of possible use to those inland (as well as on the coast) because of higher incoming skip arrival angles although domestic slop is worse than at sunset. This station has been heard in California around 0700 UTC in late autumn/early winter. Dakar - 765 runs French, Arabic, and a variety of local African languages. Music is quite diverse. You may hear Arabic-Islamic chanting, flutes, violins, soul/reggae, or exotic central African folk melodies. The other Senegal stations such as 810, 963, 1224, 1287, 1305, 1323, 1368, 1503, and 1539 are much more difficult, but might be found on a Beverage during aurora.

SAUDI ARABIA: Superpowered Duba - 1521 makes this rather-distant Trans-Atlantic country a regular in the autumn and winter from east coast sunset to 2300 and then again at 0300 sign-on. Programming is Arabic music and talk, mostly of an Islamic religious nature. This station really gets out and reception of it from Texas (with KOMA nulled) is not uncommon. The same program is broadcast on several shortwave frequencies. Consult the *WRTH* for these parallels. Less frequently reported are outlets on 648 and 1512 kHz. Al Qurayyat (Guriat) on 900 has been noted sometimes dominating co-channel Italy at DXpedition sites in the Azores and Newfoundland and I logged it from the Boston waterfront (over Italy and CKDH) once. Other big Saudi stations such as 549, 585, 594, and 1440 can occasionally compete with the generally-stronger co-channel European stations.

FRANCE: As one of Europe's larger countries (in terms of land area, population, and industrial output), France, not surprisingly, has many powerful transmitters. Many do not operate on a 24-hour schedule, so they are best heard before 2300 and after 0500. Schedules vary, so check recent DX bulletins and the *WRTH*. French talk (including drama) and a wide variety of music may be heard on 675, 711, 837, 864, 945, 1071, 1161, 1206, 1377, 1494, and 1557 kHz. Programs often feature alternating male and female announcers. Parallel frequencies, as well as programs generally in French, help identify these stations. Although longwave is beyond the scope of this article, the superpowered outlet at Allouis on 162 kHz should be mentioned as a TA propagation beacon of sorts. A high-powered transmitter on 1467 kHz, used by Trans World Radio, is located in Roumoules. It is next to Monaco and some count it as Monaco rather than France. Numerous languages, including English, are transmitted on 1467. Consult *WRTH* for current scheduling. The signal from this station is not as consistent as it had been in the '60s and '70s when on 1466. The antennas may have been directionalized to put less signal towards the USA.

NORWAY: Kvitsoy-1314 is quite good on higher-latitude evenings. A variety of music, including American and British oldies and recent hits, is featured along with Norwegian talk. The 0300 to transmitter site dawn period yields the strongest signal; earlier in the evening co-channel Spain presents more interference. Few TA's are heard from farther-north sites on a regular basis. Other Norwegian stations are orders-of-magnitude more rare. Westerners may have more luck with northern Norwegian stations than DXers in the East; such stations may skip in the auroral "doughnut hole" and thereby propagate well into the Pacific Northwest and western Canada.

ENGLAND: There are many stations in England running high power. Virgin Radio on 1215 is heard well when it's not being QRM'ed by Spain. BBC Foreign Service transmitters on 648 and 1296 kHz, which sometimes run foreign languages, are less consistent in strength than the BBC's English-language domestic channels. Here in the Boston area, 693, 882, 909, 1053, and 1089 have the best signals. Schedules on some outlets have jumped back and forth between 24-hour operation and with a silent period, the latter due to budgetary restrictions. Best reception is during the late autumn and early winter from local sunset to 0000 and then from 0500 to transmitter dawn. The British locals on channels such as 1458, 1485, and 1548 offer interesting challenges quite like domestic "graveyard" DXing.

PORTUGAL: Projecting out on the western end of the Iberian Peninsula, Portugal has a relatively low loss path to the USA. Local east coast sunset provides the best opportunity to log Portuguese stations. There are fewer high-powered stations on from Portugal now than there were a few years ago, but the country is still relatively easy to hear. The best frequencies are 1035 and 666. The rocker on 783 has an inconsistent signal: some nights good, but more often wallowing in slop from CFDR, WBBM, and R. Coro (Venezuela). 963 does fairly well and occasionally Vilamoura sneaks in on 891 as the powerhouse Algerian is fading with oncoming daylight. Similarly, there's a Portuguese station that shares 981 with the big Algerian there. I don't know how these guys get out of their own backyards when competing with those North African juggernauts. Some Portuguese stations sign off between 0100 and 0500. When they return to the air around 0500 to 0600, QRM from both co-channel Europeans and stateside stations is generally worse than it is during openings prior to 0100. Those who like even-channel (10 kHz multiple) TA's may find that Radio Comercial on 1170 is one of the easier stations to hear. After daytimers such as WKPE and WDIS go off, WWVA is the major pest. It can be eliminated at most northeast USA/eastern Canada locations by using two-wire, or loop-versus-wire, phasing techniques that set up a cardioid pattern with a null to the southwest. Formerly 720 was a good "even" channel for Portugal, but CHTN has done away with that. For some inexplicable reason (colossally-bad frequency management ?), there are some channels that have co-channel Spaniards and Portuguese (capable of being heard from North American sites) battling each other for dominance. What they must do to each other in their local areas boggles the mind. Portuguese is a somewhat nasal language, intermediate between Spanish and French in sound. Look for high-band lower-power stations such as 1251 and 1377 during the spring and summer around transmitter sunrise when farther-north Europeans are already well into daylight. These unique openings are the "Iberian high-band conditions" popular with numerous DXers on Cape Cod and Long Island.

CATEGORY B: MODERATELY EASY

GERMANY: Although on a less-favorable northern route (bearing 52 degrees from MA), Germany is commonly heard because of the large number of high-powered transmitters there. Langenberg has vacated 1593, but there are still a goodly number of targets for the DXer. Currently 756, 1017, 1269, 1422, and 1539 are the best bets. Germany now includes the former East Germany: the Radio Moscow relay there (in Nauen) on 1323 has English at times. The other stations typically have German talk and varied music including classical, big-bands, show-tunes, and rock. Hard rock with German announcements may be heard on 1422. 1539 may be separated from WPTR with a good receiver on better nights; 549 occasionally overtakes the generally stronger co-channel Algerian. The AFN/VOA stations (873, 1107, 1197) have English, but their signals are mediocre at best and, more often, they're hopelessly buried by co-channel Spaniards. Other Germans on 666, 936, 972, and 1044 are occasionally heard, but they too are at a competitive disadvantage to the various Iberians and North Africans found there. German stations compete more favorably with the lower latitude TA's during the hour preceding German dawn, rather than at US sunset.

DENMARK: Try 1062 kHz when mid-band British and Germans are strong. This station has gotten to be a better performer during the 1990's; perhaps its facilities have been upgraded. The removal of a strong Portuguese station from that channel has also helped. It generally dominates over co-channel Italy. Danish talk and a variety of popular music is featured.

AZORES: At East Coast sunset, stations on 693, 837, and 1566 are often heard. Programming is in Portuguese. 648, 828, 909, and 1394 are somewhat less common. As the Azores are well to the west of much of the other TA action, listening just before Azores sunrise is very productive. Most of the competition has been lost to daylight by then. Listening to 837 after 0700 UTC in winter is instructive: Canary Islands may be initially dominating, but as time passes, the Azores station rises to complete dominance well before its own fade-out. Lower-powered 828 may be heard best at that time (with Morocco and Spain QRM stripped away). An old-frequency plan straggler on 1259 hets WEZE/CIHI/ Spain - 1260 on occasion. A very interesting target is the American Forces station at Lajes on 1503. This flea-powered (100 watt) operation has been positively logged at the "DX Inn" site in Cappahayden, NF and tentatively logged at the Granite Pier site in Rockport, MA.

VATICAN: Radio Vatican on 1530 kHz is often logged in the Canadian Maritimes, New England, New York, New Jersey, and eastern Pennsylvania. It mixes with WCKY, sometimes overtaking it, on above-average TA nights. Several languages are used in the religious format of this station. Music played is usually "very soothing" soft instrumentals and classical music. Check shortwave parallels on 5882 and 6245.

LIBYA: Tripoli on 1251 kHz now seems to be the most reliable Libyan signal in North America. The heterodyne against the 1250 domestics is strong on many nights, but pulling up readable audio is tricky. When it does surface, the DXer will find Arabic chanting and talking. Co-channel stations on 1251 include Portugal and Hungary. There are other Libyan possibilities on 711, 828, 1053, and 1080: make sure you don't confuse these with co-channel Moroccans. Less common are 675, 792, 909, 1125, 1404, 1449, and 648 (which can be confused with co-channel Saudi Arabia). The best time to listen is from sunset at the listener's location to 2300 UTC and from 0400 until transmitter dawn.

HOLLAND: Flevoland - 747 can be a powerhouse when the auroral absorption zone moves sufficiently out of the way. Another Dutch station on 1008 is reported infrequently. Canary Islands/Spain co-channel QRM and WINS slop make this one rough. There's also 675 if you don't have WRKO - 680 as a problem. Holland has a number of pirate stations just above the top of the band. The British club Medium Wave Circle gives these quite a bit of column space. Some of these can span the Atlantic: Jean Burnell in Newfoundland has received several of them. 17. EGYPT The 1107 kHz transmitter at Batra is noted with Arabic programming at North American sunset in autumn and winter. The signal peaks up again as dawn approaches around 0300 - 0330 UTC. As the incoming skip angle is low, a seaside receiving site is advantageous, especially for sunset reception. The presence of Egypt atop Spain on 1107 points the way to other DX targets in that area (such as Turkey, Jordan, Syria, Israel, and Lebanon). Arabic programming heard behind Spain - 774 may be either Morocco or Egypt, so be careful to get positive identification material such as parallel frequencies, interval signal, characteristic time pips on the hour, or a spoken ID. Egyptians on 819 and 864 can also be confused with co-channel Moroccans. Matruh - 1593 has gotten easier now that Germany has vacated the channel.

MALTA: The Deutsche Welle relay at Cyclops on 1557 kHz, with programming in Arabic and German is commonly heard after 0300, often mixing with Nice, France. Look for the Deutsche Welle interval signal of shortwave fame heard at 0400, a change from Arabic to German announcements, or the shortwave parallel on 6025.

SWITZERLAND: The only really viable channel now is Sottens on 765. This runs French programming and classical music and is often heard well after 0100 when Dakar goes off. Sarnen on 1566 kHz is supposedly testing although it's officially de-activated.

ALBANIA: This country's broadcasting organization has been affected drastically by the demise of communism's iron grip. In a move once thought unthinkable, the big transmitter on 1395 is being used by religious organizations including Trans-World Radio. The evening programs, including English, actually get out better than those from the France/Monaco transmitter on 1467. The US/Canada sunset period in winter (2000 - 2300 UTC) yields best reception. Other frequencies such as 648, 1089, 1215, and 1458 have substantial interference from stations in Britain, Spain, and elsewhere. 1395 is your best bet.

SLOVAK REPUBLIC: This spin-off country from old Czechoslovakia is much easier to hear than its relative, the Czech Republic. Nitra on 1098 runs big power (1.5 megawatts) and it can roll over co-channel Canary Islands/Spain when northerly propagation paths are active. The Slavic talk comes in well when the major high-band Germans are strong. 702 and 1287 are other channels worth watching.

MAURITANIA: Nouakchott is a long-time straggler on the old-plan channel of 1349 kHz. It can be received at sunset during auroras that kill off most other TA's. Sign-off is at 2400 (0000). During auroral conditions favoring reception, the signal is far stronger at the seashore than it is just a few miles inland. Programming includes Islamic cultural content, African and Arabic music, and talk in French and Arabic. Check for the shortwave parallel on 4845 kHz.

ITALY: There are several Italian MW frequencies commonly reported by North American DXers. For those not in the splash zone of WHDH - 850, Rome on 846 kHz may be your best bet. This high-powered 24-hour station runs the early morning (Italian time) "Notturno Italiano" program featuring blocks of music and talk in several languages including English. 900 can occasionally make it in at coastal sites. A shortwave parallel to both 846 and 900 can be heard on 6060. The synchronized stations on 1035, 1062, and 1116 (in parallel) sign-on at 0500. Italy on 1062 has been logged in eastern Massachusetts, despite QRM from co-channel Denmark and slop from WBIV, CJRP, and KYW. 1575 and 1332 are good high-band Italian channels to check and 1116 may be noted mixing with Spain, at least during above-average conditions. If you're lucky, you may be able to slice the 1449 Italian away from the 1450 "graveyard" jumble.

IRELAND (SOUTHERN): RTE Athlone - 612 and Tullamore - 567 are your best bets. Best reception is in late autumn and early winter around 0600 to 0700. The outlet on 612 plays pop-rock music; 567 features more discussion programs and traditional folk music. Although Ireland is the closest European country (with a high-power MW station) to North America (the Azores and Iceland are closer, but neither has a MW station in the 100 kW or greater class), the stations on 567 and 612 don't get out as well as many other low-band Europeans. Partly this is due to a high bearing (52 degrees from Massachusetts), but mostly it is because the transmitter sites are in the center of the country in a low valley surrounded by mountains in all directions. If these stations were moved to the west coast of Ireland, say Clifden or Bundoran, the signals would be at least 10 dB stronger here. 567 suffers some co-channel Spain/Portugal QRM and 612 is heavily pestered by Morocco. English is the primary language used, although Gaelic is occasionally noted. If the two main stations are being heard, check lower-powered outlets on 729 and 1278. The Radio na Gaeltachta (all Gaelic language) outlets with their superb folk music programming are unfortunately low-powered. The 963 outlet near Dingle Peninsula is the most likely RNG station to be heard in North America because of its advantageous location. You have to work around potential QRM from Portugal, Tunisia, and Finland -among others. There have been a number of pirate operations in Ireland, though far fewer than in Holland.

BELGIUM: Wolvertem - 1512 is good (usually over co-channel Saudi Arabia) at sunset (2000 - 2300 UTC) if you aren't near a "megapest" like WSSH - 1510. They have programming in blocks of languages including English and German. Check the *WRTH* for details. Also, try 1512 around 0600 in winter. 927 can be heard under good TA conditions before 2400 (0000) sign-off and after 0500 sign-on. Programming is usually in Dutch, with pop music often played.

TUNISIA: Sfax on 1566 kHz often puts in a powerhouse signal from just before local sunset to 2330 sign-off. Listen for Arabic talk and music. The audio level tends to be low, however, and QRM from co-channel Azores can be heavy at times. Other channels to check are 585 (with Spain), 630 (with Portugal/CFCY/WPRO), and 963 (with Portugal and Finland).

CATEGORY C: MODERATELY DIFFICULT

CROATIA: The parallel outlets on 1125 and 1134 kHz make it in with Slavic talk around transmitter site dawn under good autumn/winter high-latitude openings. A former transmitter on 1143 appears to be inactive. If neighboring Albania on 1395 kHz is unusually loud and the high-band Germans are also strong, give these former - Yugoslavs a try.

SWEDEN: Solvesborg on 1179 is noted during the better winter sunset openings atop Canary Islands/Spain stations. Using a phasing system to throw a cardioid null at WHAM can often make all the difference in digging this one out successfully from northeastern USA receiving sites. Look for a variety of programs and languages during the 2000 - 2300 period, including English.

NORTHERN IRELAND: The heterodyne from BBC Lisnagarvey on 1341 kHz will show up against the 1340 kHz "graveyarders" many nights from 0600 to transmitter dawn during winter if the English BBC stations are present above 1000 kHz. Slicing audio from the 1340 brouhaha can be tough, though. A strong 1341 signal and a good receiver are necessary. Programming may, at times, be parallel to other BBC outlets. This, and the fact that little else on 1341 can be heard in English, will help you ID this. Sunset period reception of Lisnagarvey (before 2400) is also possible, but sunset often favors lower-latitude propagation to the co-channel Spaniards on 1341. Another Northern Ireland station remotely possible is Belfast on 1026 kHz around transmitter dawn.

RUSSIA (KALININGRAD): Bolshakovo on 1386 kHz and on 1143 kHz make it in a few times each winter, usually between East coast sunset and sign-off at 2300. When it's in, it's loud. But the southern edge of the auroral zone has to move quite far to the north. If the middle- and high-band German and British stations are strong, these stations are worth a try. Transmitter dawn openings are also possible. Foreign-service programming, including English, is broadcast in the evening.

YUGOSLAVIA (SERBIA): Beograd on 684 (behind Spain, usually) and Pristina on 1413 are your low- and high-band choices respectively. Look for these if big-gun eastern Europeans such as 1098 are in. The status of this country and the other Yugoslav spin-off "countries" such as Croatia, Montenegro, Macedonia, etc. remains in a state of flux.

HUNGARY: The parallel transmitters on 1188, 1251, and 1341 are worth chasing. I would rate 1188 the best, as it suffers less co-channel QRM than the others. It does reasonably well in the Boston area with WOWO phased. 540 is a dark-horse possibility, if you can get through a pile of domestics and, conceivably, other TA's. If uncommon low-band Germans are conquering co-channel routine Spaniards, then a distinctly above-average opening is in the works and 540 is indeed possible. Hungarian sounds notably different from the Slavic languages spoken nearby. Listen to Hungarian on a shortwave outlet to gain the ability to identify it.

POLAND: Stargard/Stettin-1503 should be checked after 0400 sign-on if the high band Germans are strong. An interval signal (on the hour) using Chopin piano music is a characteristic identifier. Consult the *WRTH* for the schedule of languages used. This is an overseas service transmitter. Harder to hear Polish stations have been noted on 819, 1206 (with France off), and on 1368 kHz.

AUSTRIA: ORF Wien on 1476 is the best channel for Austria, but it has greatly reduced its transmission schedule. Look for it around 2000 to 2200 (North American winter sunset) period. Programs are in German and music is quite varied, including electronic and "modern classical" styles. Co-channel interference from stations in Spain is sometimes a problem. There's also an Austrian on 1026 occasionally heard in the USA.

SUDAN: If Egypt - 1107 is doing well, try for Rebia, Sudan - 1296 at their 0300 sign-on. The signal can be quite massive when the dawn "greyline" is near the transmitter. An interval signal parallel to 7200 shortwave is used. Arabic talk and Koran recitation (chanting) follows. QRM is largely from Spain, although England and Bulgaria may be rattling around in there as well.

CATEGORY D: DIFFICULT

ANGOLA: Look for Portuguese programs and African music (also American/European pop) on the distinctive "old plan" channels of 944, 1088, 1115, 1313, 1367, 1502, and 1586. Auroral conditions, Beverage aerials, and a coastal location will help greatly. The best frequency will be largely determined by the DXer's local pests. In eastern Massachusetts, 1088 and 1367 are best, followed by 1115.

TURKEY: During good TA DX conditions, Istanbul (Mundanya) - 1017 can be heard, often mixing with co-channel Germany and Spain. Most receptions have been during the late autumn, between 0230 and 0330 with Turkish language programming and music intermediate in style between Greek and Arabic music. Look for this when Egypt - 1107 is rolling over more-common Spain. If this station is strong, consider the propagation door to the Middle East to be open. Have fun going after more exotic catches. Diyarbakir on 1062 has occasionally been reported by North American Beverage users, but it has a lot of co-channel competition from Denmark and Italy, for starters. Other high-powered Turks are listed for 558, 594, 630, 702, 765, 891, 927, and 954, but in every case there's something considerably stronger on each channel from western Europe and North Africa.

SAO TOME AND PRINCIPE: The new Voice of America (VOA) outlet on 1530 can do surprisingly well at 0300 sign-on through WCKY and the Vatican. The low-latitude path, high frequency, and high power all help when conditions get auroral enough to weaken the channel's other two major players. It's been logged in the Boston area several times during its first year of operation. Sometimes test tones are run around 0245 - 0255 prior to sign-on. This could be a tip-off to subsequent reception. At 0300 there is news in English, generally followed by a pop music show at 0310. Check 7405 kHz for the VOA African Service parallel. Sao Tome also has a station on 945 (in Portuguese) which could be mistaken for an Angolan. I haven't seen it logged; it might be inactive (or just hopelessly buried by others).

LESOTHO: Relay stations of the big international broadcasters have certainly helped put some formerly-rare countries within reach of North American DXers. Besides Sri Lanka and Sao Tome, Lesotho comes immediately to mind. The BBC relay on 1197 from this nation surrounded by South Africa can provide some real long-haul DX (7000+ miles) for us. It has been logged in Newfoundland, Massachusetts, and Florida as of the end of 1993. As more DXers find out about this one, other loggings will likely follow. Best reception has been during moderate aurora about an hour after receiver sunset. Look for BBC English programming parallel to 5975 and 6175 shortwave (Sackville, NB) and 1160 medium-wave (Bermuda).

GABON: Melene has sporadically been heard on 1554 kHz (an old-plan channel). This runs parallel to 4777 kHz shortwave, so checking this may be beneficial. Most reports of 1554 mention 2300 as a good reception time. Drum-oriented African music is the usual format. If this moves to 1557, reception will be much less likely, due to WQEW slop and France/Malta co-channel interference. Reception of Gabon seems to be as common in the southeast (Florida and Georgia) as in New England. Moderate aurora will help reception. There are Gabon outlets also listed for 549, 990, and 1575 in the 15 kW - 20 kW range, but hearing these would definitely require the optimum Beverage - beach - aurora combination.

MADEIRA: Portuguese language outlets on 531, 603, and 1530 have been logged in New England and Maritime Canada. All face substantial QRM on their respective channels. The right combinations of aurora, sunset or sunrise line placement, and directivity of the antenna/receiving location set-up can help pull these out. One should be advised that Portuguese heard on 1530 at sunset can be from WDJZ, a daytimer in Connecticut. Listen carefully before putting this one in the book. The 531 and 603 stations run 24 hours; Madeira - 1530 signs off at 0000 (0100 Saturday) and signs on at 0600. Other Madeira outlets on 1017, 1332, and 1485 are low-power relays not likely to be heard over stronger co-channel TA's.

UKRAINE: Over the years, Mykolayiv on 972 has been logged by Kazaross (ME), Bailey (MA), Dangerfield (PA), and Hakiel (NY); their locations are apparently conducive to eastern European DX. Ukrainians on 1242, 1377, 1404, and 1431 were heard well along with 972 from Cappahayden, NF during the October 1993 DXpedition. The report from that DXpedition is a valuable reference for TA DX in general, but especially for the eastern Europeans that are heard much less frequently on this side of the Atlantic than the routine Spaniards, Moroccans, etc. Sunset (2000 - 2200) reception from the shore and later (approx. 0300) general reception periods are suggested for stations in the Ukraine, Russia, and neighboring areas.

ROMANIA: During a good opening to eastern Europe, Romanians can compete with the more common TA's on 558, 756, 855, 1053, 1152, and 1179. Most of these frequencies were logged on the 1993 Newfoundland DXpedition and some have reached the USA. Best reception tends to be during the 0400 - 0500 dawn-enhancement slot in late autumn and early winter.

BULGARIA: Every year a few Bulgarians are reported, usually by Beverage users. Some of these are on 576, 594, 747, 774, 828, 864, 1161, 1224, and 1296 kHz. Try for these on top-notch TA nights when other high-latitude Europeans are loud. It's wise to consult the *WRTH* for both the times of Bulgarian station operation and the times when the stronger western European and North African stations sharing channels which share channels with the Bulgarians are off. Although sunset (2000 - 2200) reception is possible at coastal sites, you'll usually do better around 0300 - 0400. The 1224 outlet has been heard at 2300 relaying the VOA ... how times change !

LUXEMBOURG: Marnach on 1440 kHz became tougher to hear than it had been back in the "old days" on 1439, but up till a few years ago, it was periodically heard in the northeastern USA - usually on dawn enhancement around 0500. Recently it has cut out English language programs and it has gone to a schedule with sign-off at 2400 (0000) and sign-on well after transmitter-site dawn. So now, with reception limited to the immediate post-sunset period and with heavy co-channel domestic QRM, it is MUCH harder to log from the USA. Even at the best shore sites at sunset in November and December, it's moderately difficult. At least receiver selectivity isn't too necessary, just lucky propagation. Italian and German programs are those most likely to be heard at the admittedly-limited times of possible North American reception. If Germans on 1017, 1269, 1422, and 1539 are strong, getting Luxembourg seems likely.

SCOTLAND: The BBC outlet on 810 can be parallel-checked to several BBC England channels. 810, unfortunately, is often a stew of QRM including, but not limited to, co-channel CJVA, WGY, Colombia, Puerto Rico, Bahamas, Venezuela, Brazil, and Spain ! That's a lot of crud with which to contend. Really solid openings to the UK around transmitter-site dawn in late autumn/early winter might bring this catch as well as other stations from Scotland on 1035, 1152, and 1449.

OMAN: Look for BBC programming from Masirah Island on 1413 during the sunset period and at dawn enhancement around 0300. QRM from Spain and Serbia can be rough (not to mention to slop-bruising by CIGO, WPOP, and others on 1410). BBC on 702 is not as often heard. There is also an Arabic-language station on 1242 best heard around 2100 with programs parallel to 6085 shortwave. Bruce Conti found this one on the '93 Newfoundland DXpedition. If you're getting any kind of signal from these long-haul Persian Gulf stations, then conditions just might be good enough for juicy catches from Iran, Iraq, Qatar, UAE, India, and Sri Lanka.

BENIN: Cotonou is still on old-plan 1475 kHz and it can be split away from Spain and the others on 1476. Its signal isn't too strong. Auroral conditions certainly help: its signal level would be maintained while 1476 European competition would be removed. From local sunset to 2400 (0000) and from 0400 to Benin dawn are the working times of interest. 4870 kHz may be useful as a shortwave parallel.

BURKINA FASO: Ouagadougou on 747 kHz is your only real shot at this country unless you're running Beverages from Newfoundland during auroral conditions. Sunset is definitely the best time to bag 747. Look for a strong signal from Senegal on 765 compared to a weaker signal from Spain on 774 (signalling slightly auroral conditions conducive to good African reception with reduced interference from Europeans). If Senegal is blasting in, then you'll have a good chance of hearing Ouagadougou on 747. Hit this early in the evening, as domestic skip/slop and increased atmospheric/storm noise tend to diminish reception possibilities later. You may hear African music and talk in French and local languages at an apparently low modulation level. As with all local sunset period DX, especially below 1000 kHz, the receiving site should be as close as possible to salt water in the direction of DX for optimum results. Shortwave parallels to 747 are on 4815 and 7230. There is a 10 kW station on 1008 that might make it in during aurora. Neil Kazaross heard it when he was in Ogunquit, ME.

RUSSIA (EUROPEAN): Most countries lists consider "mainland" Russia a separate country from its Kaliningrad section. St. Petersburg on 1494 is your best bet on transmitter site dawn enhancement in autumn and winter. It runs foreign service programming at times. With BBC moving off of 1089 soon, the Russian there may become easier: phasing WBAL is still the biggest challenge. Other stations such as 810 and 1116 are only likely during the best openings at coastal sites.

It should be noted that Ceuta, a not-too-difficult catch when on 1585.2, has gotten much tougher now that its frequency has been corrected to 1584.

The next countries to hear from across the Atlantic, after those listed so far, may be some on the chart on the facing page. Note that the order is alphabetical, not ranked on difficulty. Some may find a few of these to be easier than some of the first 50 countries enumerated above - ease of reception is, after all, influenced by many factors.

Surprisingly, many of these HAVE actually been heard by MW DXers in Canada and the United States.

The following countries are propagationally-possible, but do not have medium-wave operation at the present time: Andorra, Burundi, Cape Verde, Equatorial Guinea, Ghana, Liechtenstein, Rwanda, San Marino, Tristan da Cunha, Zimbabwe.

ADDITIONAL TA DX TARGETS

Afghanistan	1107 1206	Kenya	540 612 702 746 846 900 954 981
Armenia	864 1314	Kuwait	540 1134 1341
Ascension Island	1485 1602	Kyrgyzstan	882
Azerbaijan	801 1296	Latvia	1350
Bahrain	612 801	Lebanon	837 873 953
Balearic Islands	909	Liberia	558
Bangladesh	693	Lithuania	666 1557
Belarus	549 1566	Lebanon	836 or 837
Bophuthatswana	540 1098	Macedonia	810
Bosnia - Hercegovina	612 945	Madagascar	630
Botswana	621 648 972	Malawi	594 675 756
Cameroon	899 972 999 1106 1152 1286 1448	Mali	684 819
Central African Rep.	1440	Mayotte	1458
Ceuta	1584	Melilla	972
Chad	840	Moldova	594 999 1449 1467
Channel Islands	1116	Monaco	702 (see France for 1467)
China	1521	Montenegro	882
Comoros	1089	Mozambique	737 872 1008 1295
Congo Republic	863 1476	Namibia	594 747
Cyprus	963 1233 1323	Niger	1125
Czech Republic	639 954 1287	Nigeria	593 657 909 918 1170 1395 others
Djibouti	1170 1539	Qatar	954
Estonia	1035 1215 (?)	Reunion	666 729
Ethiopia	855 873 945	Somalia	962
Faroe Islands	531	Spanish Morocco (Sahara Rep.)	990 1355
Finland	558 963	Saint Helena	1548
Gambia	648 747 909.8	Seychelles	1368
Gibraltar	1458.2	Sierra Leone	1206
Greece	729 792 981 1179 1260	Slovenia	918
Greenland	700 720	South Africa	558 576 603 702 846 1035
Guinea	603 1386 (1404 inactive)	Sri Lanka	1548
Guinea-	666 738 1400 1485 (all low power)	Swaziland	954 1170 1377
India	1071 1134 1566	Syria	783 918 1125
Iran	1404 1449 1566	Tanzania	603 621 648 657 711 1215
Iraq	1530 (clandestine) 1035? 1197	Togo	1394 1502
Isle of Man	1368	Uganda	576 639 729 999
Israel	738	United Arab Emirates	729 1251 1314 1476 1575
Ivory Coast (Cote d'Ivoire	1493 1578	Wales	1125
Jordan	801 1494	Yemen	792 1008 1188
Kazakhstan	549	Zaire	1160
		Zambia	549 630 818 828 1071 others

SUNRISE/SUNSET TIMES FOR TA DXers (times = UTC, 15th of month)

SUNSET: NORTH AMERICA (receiving end of path)

Month	Denver	Chicago	Miami	Washington	Boston	St. Johns, NF
JAN	2340	2228	2239	2155	2120	1949
FEB	0013	2303	2257	2226	2156	2032
MAR	0049	2342	2317	2301	2235	2120
APR	0129	0025	2339	2340	2319	2213
MAY	0202	0100	2357	0011	2355	2257
JUN	0222	0121	0008	0030	0017	2323
JUL	0215	0114	0004	0023	0009	2304
AUG	0146	0043	2349	2356	2338	2236
SEP	0109	0003	2328	2320	2257	2146
OCT	0030	2321	2306	2242	2214	2055
NOV	2353	2242	2246	2207	2134	2006
DEC	2333	2220	2235	2148	2112	1939

SUNRISE: EUROPE/NORTH AFRICA/NEAR EAST (transmitting end of path)

Month	Senegal	Portugal	England	Germany	Italy	Turkey	Saudi Arabia
JAN	0733	0748	0759	0701	0632	0514	0336
FEB	0724	0717	0708	0617	0558	0442	0319
MAR	0712	0643	0613	0528	0519	0406	0259
APR	0700	0604	0512	0434	0436	0325	0237
MAY	0650	0532	0421	0350	0400	0252	0219
JUN	0644	0514	0349	0323	0339	0233	0209
JUL	0646	0521	0401	0333	0347	0240	0213
AUG	0654	0547	0446	0411	0417	0308	0228
SEP	0706	0623	0543	0502	0457	0345	0248
OCT	0718	0701	0642	0554	0540	0425	0310
NOV	0730	0736	0739	0644	0619	0501	0329
DEC	0735	0755	0811	0711	0640	0521	0340

about authors and editors

about authors and editors

GUY ATKINS — 5323 S. ISLAND DRIVE, BONNEY LAKE, WA 98390

Guy is 38 and married fourteen years to Rochelle. They are kept amused by their three year old daughter (and future DXer) Melanie. A second child is scheduled to sign-on in late September. Guy is with the Quality Assurance Dept. of Zetec, a manufacturer of nuclear powerplant safety inspection systems used worldwide. Prior to Zetec, he spent nine years in graphic arts.

A battered Sears Silvertone portable was responsible for Guy's first enthusiasm in radio at age 13. His DXing interests began in 1982 when he met other SWBC hobbyists in the Seattle area. In the late 1980's he promoted the hobby through publication of the Cascade Mountain DX Club's newsletter and DX-Northwest's *Grayline Report*. Guy has also hosted get-togethers for area DXers and organized DXpeditions. He is currently is on staff with *Proceedings*.

Drake R7 and R8 receivers assist Guy in roaming the mediumwave and tropical bands for favorite targets from the South Pacific. Washington State's Midway and Grayland beaches are favorite sites for DXpeditions throughout the year. He also enjoys antenna experimentation and currently uses a Carolina Beam from The Radio Works Co. and a terminated 380 ft. mini-Beverage aimed at Papua New Guinea and Irian Jaya.

Guy is enthusiastic about ethnic music from nearly everywhere and can often be found camped on 3365 kHz enjoying Radio Milne Bay's native "sing-sings".

JERRY BERG — LEXINGTON, MA

Jerry is 50 years old, married, and has two children, Evan, 23, and Laurie, 20. He is a graduate of Temple University and Georgetown University Law School, and is the court administrator for the Massachusetts District Court system. Jerry has been a SWBC DXer since 1958. He is a member of the NASWA Executive Council, author of various articles, and chairman of ANARC's Committee to Preserve Radio Verifications. He was selected as ANARC's 1992 North American Shortwave DXer of the Year. In addition to his DXing interests, in recent years Jerry has concentrated on shortwave history.

BILL BOWERS — BOX 399, DAVENPORT, OK 74026

Born in '26, Bill spent two years in the Navy and then back to school to get his BS in EE, MS in Physics and later a P.E. For over 40 years, he has been involved in the design and manufacture of complex electrical cables. He managed plants in Mexico, Canada, and the U.S.A. before retirement.

Addiction to radio DXing dates back to the early 40's with 01A regenerative receivers. Bill's principle interest has been in the L.F. range where he received the John Clements award in 1993. Under the influence of John Bryant, this interest has been pushed up a megahertz to include MW. Antennas have always been his special interest and his wife, Faye, now tolerates antennas erected all over their 80 acre home.

BOB BROWN, NM7M — 504 CHANNEL VIEW DR., ANACORTES, WA 98221

Bob is 71 years old and has been married to Mary Lou, NM7N, for 15 years. In 1982, Bob retired from the Berkeley Campus of the University of California where he served as Prcfessor of Physics. Bob spent a year at the Royal Geophysical Observatory in Kiruna, Sweden in 1963 as a Guggenheim Fellow and a Fulbright Scholar.

Bob's research specialty was the radiation bombardment of the D- and E-regions of the ionosphere at polar latitudes. He points with pride to being the first person to observe X-rays from electrons shaken out of the Van Allen radiation belt by the sudden commencement of a geomagnetic storm and his balloon group was the first to observe X-rays from auroral electrons precipitating simultaneously in the Northern and Southern Hemispheres. On retirement, Bob stopped looking straight up and started a new career, studying oblique radio propagation via the F-region, and he finds that much more enjoyable and not a pain in the neck, as was the case with his earlier career.

JOHN H. BRYANT — RT. 5, BOX 14, STILLWATER, OK 74074

John is 53 and has been married to Linda for 30 years. John is Professor and former Head of the School of Architecture at Okla. State Univ. John is a professor of architecture and a widely known expert on the traditional architecture of East and Southeast Asia.

John has had 2 careers in the DX hobby. The first was as a teenager in 50's. John began in 1952 as a SW DXer but spent most of that era as a "medium waver." His second career, mostly SW this time, began in 1979-80 with the purchase of a Sony 2001. He currently operates a highly modified NRD-525 and a re-manufactured Hammarlund SP 600 coupled with a semipermanent 450' Beverage antenna array. Although he is enthusiastic about DX from anywhere, John couples his "real world" interests with his DX interests by being absolutely obsessed by DX from East and Southeast Asia. His other radio interests include antenna and propagation experiments and vintage radio collecting and restoration. John is the Editor of Special Publications for *Fine Tuning*.

PHIL BYTHEWAY — 9705 MARY NW, SEATTLE, WA 98117

Phil, 41, has been married to Sherry for 18 years. Younger Bytheway's include son Tony, who is 14 and daughter Tina, who is 7. Phil is a Principal Design Engineer for Alliant Techsystems (formerly Honeywell Marine Systems) designing state of the art circuit boards and integrated circuits for signal processing applications. Phil has been designing digital electronics for 18 years, at all levels of integration.

Phil has been a BCB DXer since 1968 when he won a contest in Junior High School for hearing the farthest station on the AM band (KSL-1160 in Salt Lake City, UT). At this time, Phil has heard nearly 2000 stations on the AM band. He has done some shortwave, longwave and TV DXing, but BCB is his first love. In addition, Phil's love for receivers and especially 'hollow state' gear has kept his basement radio room full for several years. He has a modest collection of Collins and Hammarlund communications receivers. There are a few solid state rigs as well. Phil's current DX set-up includes an R-390A, SPR4, R-70, all used in conjunction with KIWA and Sanserino air-core loops. Phil has been very active since the early 70s in the International Radio Club of America, holding a variety of positions including President, Publisher, convention co-host and column editor. He is currently manager of the Bookstore, ANARC Rep and Publishing Co-ordinator. Phil is also Editor-in-Chief and Publisher for the 'DecalcoMania' club (radio and TV promo/aircheck collectors) and Publisher for the PNBCDXC (Pacific Northwest DX club). Phil's non-radio interests include church, WWI airplanes, football and science fiction.

DAVID M. CLARK — 3 WIARTON CT, THORNHILL, ON L3T 2P3

David is 48 years old, a university graduate in history and geography, and works as a Director of Systems Development for a major bank in Toronto. In 1993, family priorities caused the Clark household to move back to suburbia but he still has access to the infamous 'DX Barn' and Beverage farm at his rural property near Newmarket, Ontario.

Tropical Band DX from Indonesia and the Indian sub-continent has been David's primary pursuit since 1982. Complementing this focus, together with John Bryant and more recently joined by Tony Ward, David is continuing a long term study of seasonal reception phenomena associated with short and long-path Tropical Band propagation from Asia. DXing trans-Pacific Medium Wave targets is of special interest during occasional DXpedition visits to the Pacific Northwest.

Currently, the primary DXing gear is from Drake: two each of the R8's and the R7. In addition, David continues to build his collection of the better tube-type communications receivers, mostly of Collins or Hammarlund origin. Inspired by the two "radio professors", he has also taken an interest in the Zenith Trans-Oceanic line.

David is a former Chairman of the Ontario DX Association and edits the "World Radio Report" column for the club bulletin - DX Ontario. He is also a member of NASWA, NU and FT, while serving on the staff of *Proceedings* since 1989.

HAROLD CONES — 2 WHITS CT., NEWPORT NEWS, VA 23606

Dr. Harold "Dr. DX" Cones is a Professor of Biology and Chairman of the Department of Biology, Chemistry and Environmental Science at Christopher Newport University in Newport News, VA. Trained as a biological oceanographer and benthic specialist, Dr. Cones classifies himself as a Field Biologist and prefers to spend his teaching time outdoors rather than in a classroom. He takes his students on 11-day extended ecology field trips (camping) to Maine in the spring, and to Florida in the winter and conducts similar field experiences for museums and other educational institutions. He is 51, has been married to a high school librarian for 29 years, and has two daughters ages 22 and 19.

Harold began DXing in 1957 with a BC-312 tank radio, dropping in and out of the hobby until 1983 when he again began DXing in earnest. He uses a Hammarlund HQ 180A, a Yaesu FRG-7700 and a Drake R-4B, and loves to DX on old tube equipment. His favorite area of DX specialization is the Far Pacific, however he will chase any Tropical Band DX. He has heard 229 NASWA countries, verified 220 and has earned 47 NASWA awards. Harold conducts the North American DX Championships each year, is the awards chairman for NASWA and is the co-host and program chairman for the Annual Winter SWL Fest. He is on the ANARC Executive Council and the Executive Board of NASWA and belongs to the Great Circle Shortwave Society, FT and the Old Dominion DX Association.

In the last two years, Harold has teamed with John Bryant to research the early history of the Zenith Radio Corporation. The first book in this effort, *The Zenith Trans-Oceanic: The Royalty of Radios*, published by Schiffer Press, is due in bookstores by Christmas 1994. As part of this new phase of his radio interest, Harold is a member of the Antique Wireless Association, the Society of History and Technology and the Radio Historical Society.

MARK CONNELLY, WA1ION 30 WILLIAM RD,, BILLERICA, MA 01821-6079

Mark recently turned 45 and has DX'ed MW, LW, and SW on and off since 1960, the year he set up his first "DX Lab", in Arlington, MA, for homebrewing devices to enhance reception. He's been active as a ham (WA1ION) since high school days in 1967. Early radio interests led to an EE degree from Boston's Northeastern University and to a career in the Automatic Test Equipment (ATE) industry; presently he works at Raytheon designing software and hardware to test complex circuit cards and modules. Mark lives with his wife Mary Lou and his 12-year old son Michael in the suburbs 15 miles northwest of Boston. Mediumwave DXpeditioning to coastal sites is a major interest. In November of 1991 he teamed up with Jean Burnell and Neil Kazaross to run a highly successful DX session from Newfoundland. 65 countries were logged on MW in three nights of DXing on seaside Beverages. Mark led an equally successful return trip to Newfoundland for DXing in the fall of 1993. The main receivers used at home are the R390A, a Drake R8, and a Sony ICF-2010. Mark's other hobbies include photography, many kinds of music, gardening and tree cultivation, travel, computers, architecture, exercise-related activities, and "lightwave DX' with binoculars and telescopes. Mark regrets that AM radio doesn't mean as much to young people today as it did to '60s youth and that DX hobby interests are down as a result.

RICHARD A. D'ANGELO WYOMISSING, PA

Rich is 44 years old, a native of Brooklyn NY, and has been married to Susan for 21 years. They have two children, Adam and Jennifer. Rich received a BS in Economics from Brooklyn College in 1972 and his MBA in Finance from Pace Univ. in 1976. He is employed by Metropolitan Edison Company, an electric utility, as a Manager in the Rate Department.

Rich began DXing in 1964 when he discovered his brother's Hallicrafters S-85 in the basement. His current receiver is a Drake R-8. Rich has been an active member of many DX clubs over the years and has been a member of NASWA since 1966. He was the first Manager of the NASWA Company Store and is a past Chairman of the Awards Program Chairman. Recently, he became the club's Executive Director. Rich has also served in a variety of capacities for SPEEDX—a member of the Board of Directors; a member of the Editorial Committee and as ANARC Representative. Rich is the World DX Club's North American Representative and writes a column for the club's bulletin about the North American radio scene. Other club/hobby affiliations include ODXA, NRC, A*C*E, DSWCI, OZ DX, DX Australia, FT and NU. He is currently Chairman of the joint NU/FT Special Transmissions Committee. The Association of North American Radio Clubs appointed him Interim Coordinator of ANARC in December 1991. Subsequently, he has been elected the associations Executive Secretary and later chairman of the Executive Board.

Rich focuses primarily on shortwave broadcast DXing. His major listening interest is Latin America although Africa and the Pacific region have been favorites over the years.

GERRY L. DEXTER LAKE GENEVA, WI

Gerry has been a SW enthusiast for over 40 years. His main areas of interest are Latins, clandestines and QSLing. He has over 1400 SWBC stations QSL'd (using NASWA guidelines). Gerry has written widely about aspects of the hobby including several books on QSLing techniques. Dexter writes the *"Listening Post"* and *"Clandestine Confidential"* columns monthly in *Popular Communications* as well as feature articles for that magazine as well as *Pop Comm's "Communications Guide: The Radio Shack Quarterly"*.

After a career in commercial broadcasting, Gerry transitioned to full time writing, editing and publishing. Since the early 1980s, he has operated Tiare Publications which has published over 50 books on SW listening, ham radio, and scanner and satellite monitoring.

When not involved in radio, Gerry can often be found with his extensive collection of Stan Kenton records. Gerry and Sharon have one son, Don who is an electronic/computer engineer.

BOB ELDRIDGE, VE7BS ERICKSON RD., PEMBERTON, BC V0N 2L0

Bob was born in 1921 and educated in England. He met Claire in Belgium in 1944 and married her in 1947. Bob served in RAF Signals from 1940 to 1950, and the rest of his working life in communications until retirement in 1982 to a property with lots of room for big antennas in a mountain valley 70 miles north of Vancouver BC. He represented Canada at many CCIR conferences and at WARC-79. He was awarded the Diploma of Honor for outstanding contributions to the work of CCIR. He is a Life Senior Member of IEEE.

Bob helped his father build a Lissen Hi-Q Five about 1930, joined the British Short Wave League and built an "Artificial Aerial" transmitter. From 71946, he operated as D2GQ at Luebeck and G3AGQ in England. He moved to British Columbia in 1953 and was licensed as VE7BS before collecting his checked baggage from the railway station! He operates on all HF Amateur bands, mainly on CW, but is dedicated to 160 meters. His main interest is propagation across the Pacific, but he also dabbles in writing, chess, music and the computer.

JOHN FISHER 47 NICHOLSON CRES., AMHERSTVIEW, ON K7N 1W9

John is 37 years old and has been married for 13 years to his wife Catherine. They have 3 daughters, Allison (9), Stephanie (7) and Carolyn (1). After graduating in chemical engineering from the Univ. of Waterloo, he worked in Alberta and New Zealand before returning to his old stomping ground of Eastern Ontario. He is a professional engineer and is employed as a Technical Group Leader for DuPont Canada in Kingston, Ontario.

He discovered DXing in 1970 when he began listening on an old Westinghouse floor console radio. Since that time he has maintined a relatively steady interest in the hobby, with some less active times during university. His main areas of interest have always been Latin American stations, and propagation to this area. An unabashed QSL collector, his country totals are HIC 224, VIC 213, with over 600 stations verified.

John is currently the Tropical Band editor for the Ontario DX Assoc. He enjoys DXpeditions for the chance to meet his fellow DXers and chew the fat. John values the friends he has made in the hobby and says that no matter where he travels in the course of his job, there is always a DX friend nearby.

WERNER FUNKENHAUSER 28 AVENUE RD., CAMBRIDGE, ON N1R 1B7

Werner is a 52 year old Professor of Computer Applications in Manufacturing. He has been DXing since 1956 when a neighbor gave him a 1938 General Electric "All-Wave" receiver. Later he graduated to a Knight-Kit "Ocean Hopper" regenerative radio. Since then, he has been in and out of the hobby and returned most recently in 1985 when he joined The Ontario DX Association.

Werner is a dyed-in-the-wool mediumwave DXer and rarely listens on other bands. He is editor of ODXA's Foreign Medium Wave column, "Medium Wave International". When not DXing, he spends some of his hobby time building and modifying loop antennas. A number of years ago, he acquired a Connelly longwire/loop antenna phasing unit and became interested in the effects of phasing with antenna combinations. More recently, he is DXing mainly with his Kiwa Mediumwave Loop except when he has the opportunity to DX at his Georgian Bay cottage location where he can string Beverage antennas in various directions.

JAMES GOODWIN 44 CHARLES ST. W., #2807, TORONTO, ON M4Y 1R7

James was born in Toronto 62 years ago; he is unmarried and retired. He started DXing the broadcast band in 1938 and three years later discovered the BBC on shortwave. RTTY and fax became the exclusive interests for a twenty-year period starting in 1970. A home-brew fax machine which produced clouds of acrid, blue smoke brought pointed suggestions that broadcast DXing would be healthier for everyone in the vicinity. Nowadays, James is a very casual listener, tuning in mainly to Asian marine CW and Arabic programs. Numerous receivers on hand are more for pulling apart than for reception.

James has been a travel agent and has been employed in life insurance administration and as a government bureaucrat in taxation and in small business development incentives. Present volunteer activities include work in hospital records maintenance and as ODXA's membership secretary.

He worked for a few years in four European countries. There he discovered once when penniless that shortwave can be a life saver. Having learned an anti-Red form of spoken Spanish from the VOA in the late 1940's, he was able to get and hold a job in Franco's Spain under security police surveillance. During the frequent interviews, the police were most satisfied with the subject's quick, politically correct answers.

NICK HALL-PATCH, VE7DXR VICTORIA, BC

Nick is in his 40's and is married to Susan, a piano teacher. She, along with their two daughters, Lucy and Clare, tolerate, but don't particularly understand, DXing. Nick's interest in the electronics side of DXing dovetails with his present employment designing, building, and modifying instruments for oceanographic research.

An ongoing interest in improving MW DX reception has marked Nick's DX career since the mid-60's, when he first started to experiment with receivers and antennas. He has been technical editor for the International Radio Club of America since 1978, and was editor of IRCA's "A DXer's Technical Guide," published in 1980 and 1983, and in German translation in 1987. He is also a member of CIDX and LWCA, and is a radio amateur, VE7DXR. Mongolia and Bulgaria are among the better MW catches from his home, but most good DX is now heard by using Beverage antennas on expeditions to the Pacific coast. He prides himself on never having seriously DX'ed with a stock receiver, and presently uses a receiver of his own design and construction.

DON JENSEN KENOSHA, WI

Don has been an active DXer since 1947, when, at the age of 11, he was introduced to radio by his father, a sometimes bootleg "ham". Even at that tender age he was intrigued by geography and far-away places. He found it a marvelous adventure to sit at home and tune in places like Quito, Ecuador, and Bern, Switzerland, his first two DX catches. While he dabbled in different aspects of the listening hobby over the years, his primary interest has remained

SWBC. He has been active in the hobby in numerous ways. In 1964, he founded and was the first executive secretary of the Association of North American Radio Clubs (ANARC). He has held editorial and administrative posts in a number of radio clubs, including NASWA for nearly three decades. From 1969 through 1989, he published and co-edited the *Numero Uno* DX weekly, and remains editor emeritus of that publication. He has been a freelance magazine writer since 1963, and currently is contributing editor of *Popular Electronic's* "DX Listening" column. For more than a quarter century his columns and articles have appeared in a number of radio magazines.

Don formerly was employed in broadcasting, in television and, later, as a radio news director. For more than 30 years he has been a newspaper editor and writer. He is married to Arlene, also a journalist, and they have three children, ages 25 to 37.

FRITZ MELLBERG — CEDAR RAPIDS, IA

Fritz is 49 and is a pastor of the United Church of Christ congregation in Hiawatha, Iowa, a suburb of Cedar Rapids. He is married and has two grown girls. He grew up in Menasha, WI and worked for the Appleton (WI) Post Crescent while in college at the Univ. of Wisconsin. He worked as a writer and PR person for his denomination's office of communication in New York City where he learned to edit by being ruthlessly edited by others on the staff.

Among his current hobbies are woodworking, sculpting, and collecting old radios, parts and literature. He has a large collection of old tubes as well as a few working Atwater Kents and Philcos, and enjoys learning to repair these old classics.

He bought his first SW radio to keep up with the Green Bay Packers while in India back in 1968, but it wasn't until 1979 that he began to DX seriously. He has been a member of the major DX clubs and currently spends his time DXing on the broadcast band. He advocates tape collecting as an alternative to QSLing, but admits he is not a purist and proudly displays his 3 QSLs!

CHUCK MITCHELL WB9NWF — 8367 LAKESHORE TR. E., #1614, INDIANAPOLIS, IN 46250

Chuck Mitchell resides with his wife Mary in Indianapolis, Indiana. He is currently supervising a technical support team for a computer graphics manufacturer. Chuck has also worked professionally in audio engineering and radio production. He even worked a short term assignment with TWR in Monte Carlo ten years ago. Chuck's DXing interest ignited at the age of 12 when he received a multiband portable as a Christmas gift. Two years later he earned a ham ticket. Chuck's international travels have included stops at many SWBC stations like HCJB, Radio Nederlands, Swiss Radio, several stations in Brazil and the Dominican Republic. DXpeditioning is tops on his list of favorite radio activities. Other diversions include QRP HF hamming (WB9NWF), audio recording, astronomy, photography, electronic construction, computer video production, target shooting, backpacking and cycling.

DON MOMAN, VE6JY — BOX 127, LAMONT, AB T0B 2R0

Don is 40 and earned a BSC degree in Electric Engineering in 1975. His hobby interest started in his early teens with MW DX, and graduated quickly to SW using the usual 5 tube AC/DC specials until finally acquiring a "decent" set, an old RCA GR-10 WWII receiver, but in a quiet, rural location and lots of wire, reception was great!

The hobby was put on hold during the education and career years, but like many of us, he got back into it with a better radio and a poorer location. That's about the time he discovered DXpeditioning. He then got involved with CIDX as a SWBC editor and later became its secretary/publisher. Finding the career interfering with the hobby, it was time to retire (the career, that is!) and move out in the country to grow (or raise?) antennas.

Don's interests have been varied, but certainly Foreign BCB DX is at the top of the list. From his far inland location, any DX can be a challenge, with some pretty dry years between, which leaves lots of time for the rest of the bands including SWBC and utility DXing. Recently, as VE6JY he has been more active in the DXing and contesting areas of amateur radio. Current totals on SWBC (NASWA) are 165 heard (not many verified—usually he is content just to hear and tape them nowadays), and 299 ARRL ham countries worked including 115 on 80 meters. Like on the SWBC bands, he finds DX on the "tropical" ham bands to be his main interest and challenge, especially on 160 meters!

Don is also very interested in the technical side of the hobby, receiver modifications, antenna building and experimenting, etc. This led to starting Shortwave Horizons, a specialty SWL mail order outlet that is till alive but not that active—again, it was just taking too much time from the hobby! His main (and favorite) receiver is the Yaesu FT-1000 transceiver; other units to choose from in the shack include the R-5000, ICOM R71 and R7000, Racal Ra-17, and a Collins 51S-1.

Within the last two years, a move to an 80 acre even more rural location, has allowed the installation of multiple beverage antennas, along with a variety of towers and beams. The 4-30 log periodic will be moved over later this fall.

DON MOORE — DAVENPORT, IA

Don is 36 years old. Originally from PA, he received a BS from Penn State in 1980. From 1982-84 he worked with the Peace Corps in a rural Honduran high school. While there, Don made several trips to Guatemala and Mexico, and met his wife, Theresa Bries, also a Peace Corps worker. In 1985 they spent 6 months traveling in South America. In 1989 they received MA's in Linguistics/TEFL at Ohio Univ. Don teaches English as a Second Language at Teikyo Marycrest University in Davenport. They have a four-year old daughter, Rebecca.

Don began DXing in 1971, and has been more or less active ever since. Although he dabbles in just about everything, his main interests are SWBC and MW, especially Latin American stations. During his Latin American travels, he has visited over 100 radio stations. He enjoys QSL collecting from both big and small stations, and is especially proud of his collection of over 120 different HCJB QSLs. He has over 1000 SWBC stations heard and over 500 verified. Other interests include folk music of all types, history, science-fiction, gardening and camping.

TOM NAPOLITANO — 17748 WOODSIDE, LIVONIA, MI 48152

Tom is age 50 and married to Melanie. They have two teenage children, Mandy and Jay. He has been DXing and generally tinkering in electronics since the age of 13 and just had to be the first on the block with a microcomputer in 1976. A special interest in listening to SE Asia came as a result of time spent teaching mathematics in Melaka, Malaysia with the Peace Corps. He also is active in gardening and backpacking.

BRUCE PORTZER, N7ECJ — SEATTLE, WA

Bruce has been a DX listener since 1964 and a ham since 1982. His early interest in radio and electronics lead to a BS degree in Electrical Engineering from the University of Washington, and a career designing various types of communications and control systems. Bruce currently works for a consulting firm, planning, designing and implementing everything from security systems in prisons to audio-visual presentation systems in corporate boardrooms. Now 43 years old, he and his wife, Evelyn have two children, 7 year old Theresa and 3 year old Steven.

Bruce has DXed most of the radio spectrum between 100 kHz and 500 MHz at one time or another. However, his first love remains the AM broadcast band, where he has received 2400 stations in 45 states and 72 countries. He has been active in the International Radio Club of America for many years, including 10 years as editor-in-chief of its bulletin DX Monitor, and two terms as its president. His biggest DX thrill is going on beverage expeditions around Washington and British Columbia, especially for medium wave DX from Asia and down under. His shack at home currently includes an R-390A and a Yaesu FRG-7 with Radio West and Kiwa loop antennas. His other interests include camping, computers, and playing with the kids.

MARK SEIDEN — MIAMI, FL

Mark is a trial lawyer by profession and lives in Miami, Florida with his wife and two children. Mark became interested in DXing at age 14, just before the 1962 Cuban Missile crisis. His first receiver was a National NC-60, followed by an E.H. Scott SLR-M ship's radio. An Allied SX-190 arrived in 1972. After a long hiatus, Mark resumed DXing in 1987 with an R71A and NRD-525. In the years following, his interest in receivers led to a Drake R-7, and NRD-535D and an NRD-93.

Mark is active in DX South Florida, *Fine Tuning* and The National Radio Club. His DX interests include BCB DX, Pirates, The Tropical Bands and Utilities. In addition to DXing, Mark races sports cars and, over the past 25 years, has driven everything from SCCA Formula Vees to 750 horsepower IMSA GTP prototypes.

HAROLD SELLERS, VE3SSH — NEWMARKET, ON

Harold is 42 years of age. He has been married to Linda for 17 years and they have two young children, Raelene and Brent. His training is as an electronics technologist and he works as a Communications Maintenance Specialist in Air Traffic Control Systems for the Canadian government's Department of Transport. His work takes him around the province of Ontario. Living in Newmarket, a town of 45,000 people 40 km north of Toronto, Harold finds this to be a good DXing location and it is actually very close to his childhood home where the DX bug first bit.

Harold has been DXing since 1968 and presently specializes in SWBC DX, both tropical and international bands. Approximately 190 countries have been heard, with over 150 verified. He has been a club editor and/or executive for over 20 years and presently serves as the Managing Editor and General Manager for the Ontario DX Association. Harold is one of the founders of the ODXA and served as Chairman of the club from its founding in 1974 to 1990. The receiver at present is a Japan Radio NRD 515.

TONY WARD VE3NO — 32 HOLLIDAY DR., WHITBY, ON L1P 1E6

Born in New Zealand 52 years ago, Tony grew up thinking that everyone lived on a beach, ate all the shell-fish they felt like gathering, and enjoyed listening to 250 watt medium wave stations 6,000 miles away any time they felt like tuning in. He also came to feel that the wire of any bush telephone system not actually in use was meant to be added to his personal antenna system, and only luck prevented his gaining a permanent criminal record.

Tony started in SW DX, migrated to MW when he ran out of countries to hear, and went on to FM and TV DX from Ontario in the early 1970's. When that palled he became a radio amateur and was extremely active in contest and DXing circles, mostly during a 5-year stint back in NZ as ZL1AZV. He built a number of very large antenna systems for the HF bands, indulging a growing appetite for experimentation in the murky relationships among antennas, propagation, and the arrival angle of DX signals, which is on display in these pages. This to third place in the 1981 CQ World Wide Contest. He also went on a number of Pacific Island-hopping DXpeditions. Returned to Canada in 1982, he was so appalled at the poor reception now that he was no longer on a high hill overlooking Auckland harbour with a 110 foot tower that he retired to 2m after serving a year as president of CANA-DX. His friend and co-author David has tempted him back onto the Tropical bands where he hangs out mostly in the afternoons, interpreting faint whistles as 300 watt Indonesians, just like his mentor.

Tony currently DXes with a Sony SW77 and Drake R8 from his home location in Whitby Ontario. He also enjoys SWLing with a Kenwood TS50S in the car, and (very rarely) transmits, as VE3NO. There are currently more than 3,500 feet of wire creatively draped through the trees in the ravine lot behind the house; mostly as long-wires or Beverages, plus a Carolina Beam. Between band openings he is Head of Geography at a local high school, sells computers, cross-country skis, travels with his wife and two young daughters, takes photographs, and indulges a passion for advanced Astronomy with an indecently large collection of telescopes.

LARRY YAMRON — PITTSBURGH, PA

Larry is 38 years old, and works as an Advisory Specialist for the IBM Corp. He and his wife Sharren reside in a suburb of Pittsburgh and have two sons, Samuel and Todd. Larry has been an active DXer since 1970 and enjoys DXing the tropical and short-wave bands. Although primarily a SWBC DXer, Larry also enjoys chasing foreign mediumwave and longwave DX stations. Other areas of interest include, DXpeditioning, antennas, receiver mods and collecting old tube radios. Larry's shack currently consists of an ICOM-R71 (modified), Lowe HF-150 and R390A. Antennas at Larry's QTH are always changing, but the current crop includes a 400 ft. terminated beverage, 200 ft. mini-beverage and a 90 ft. longwire. A Farley SW loop also graces Larry's shack. Larry also is the Publisher/Editor of *Fine Tuning* for the past 10 years.