

BETRS RADIO APPLICATION GUIDELINES

CONTENTS

1. GENERAL
2. EQUIPMENT AND SYSTEM CHARACTERISTICS
3. PRELIMINARY PLANNING
4. RADIO SYSTEM DESIGN
5. FCC RADIO STATION AUTHORIZATION
6. SYSTEM SPECIFICATIONS
7. SYSTEM PROPOSALS
8. SYSTEM IMPLEMENTATION

APPENDIX 1 - EXAMPLE OF BETRS EQUIPMENT SPECIFICATIONS

- FIGURE 1 - POINT-TO-MULTIPOINT BETRS RADIO SERVICE
FIGURE 2 - POINT-TO-POINT BETRS RADIO SERVICE
FIGURE 3 - BETRS RADIO REPEATER SERVICE AREA
FIGURE 4 - SIMPLIFIED PROFILE VIEW OF RADIO PATH

1. GENERAL

1.1 This section provides REA borrowers, consulting engineers, manufacturers, contractors, and other interested parties with application guidelines and recommendations on radio systems for Basic Exchange Telecommunications Radio Service (BETRS). BETRS is a telecommunications rural radio service used as an alternative to traditional telecommunications facilities. The information and recommendations in this section are advisory. A basic description of the BETRS concept and equipment is contained in a companion Section 948, Basic Exchange Telecommunications Radio Service.

1.2 This section addresses BETRS application in the 150 and 450 MHz bands that are co-primary with the Public Land Mobile Service and the 800 MHz band that is co-primary with the Private Land Mobile Service as authorized by the Federal Communications Commission (FCC). BETRS in the 800 MHz Cellular band is not covered in this section.

1.3 While this section is intended to aid REA borrowers in the design, procurement and implementation of BETRS for rural telecommunications service, it is not intended as a complete reference on BETRS radio system design. Specialized knowledge and reference material are required to design radio systems. This section merely highlights selected aspects of radio system design for adequate telecommunications service and for approvals and conformance to requirements by the REA, FCC, and other local, state, and national organizations. Much of this material is necessarily abbreviated to reduce volume.

1.4 As reference material is subject to change, the latest issues of source reference documents should be obtained, reviewed, and addressed. The

discussion and explanation of outside references contained in this section serve as a guide, but may be outdated because of changes in source references. For instance, the latest FCC Rules should be addressed in FCC license applications. Electrical codes are periodically revised and code requirements may vary with localities.

1.5 This section is arranged as follows. Paragraph 1 provides a general introduction of BETRS and an overview of this section. Paragraph 2 summarizes BETRS equipment from an application perspective and complements the equipment information in TE&CM Section 948. Paragraph 3 highlights some suggested preliminary planning that should precede the actual design of a BETRS system. Paragraph 4 highlights the design stage of a BETRS system. Paragraph 5 highlights some aspects of the procedure and information required in obtaining an FCC Radio Station Authorization. Paragraph 6 summarizes specification considerations for BETRS contracts. Paragraph 7 highlights the review of Seller system proposals. Paragraph 8 highlights some considerations in the installation and implementation of BETRS.

1.6 BETRS equipment and BETRS applications should provide standard telecommunications service that is equal to or better than wireline service. The BETRS system should provide service that is transparent to standard telecommunications interfaces and to the subscriber. This means that the BETRS radio equipment and systems are substitutes for conventional outside plant cables and carrier systems interfacing with central office equipment, telephone sets, and other customer premises equipment meeting FCC Part 68. BETRS equipment should provide some remote testing capability to minimize travel to customer locations scattered over a wide area.

1.7 BETRS may be used for first time service to an unserved area, or may be used to supplement or extend service within an existing service area. For temporary or permanent service, BETRS radio should be considered as an economic alternative to conventional telecommunications cable and carrier to:

- a. Serve subscribers scattered over a wide area.
- b. Provide new service or upgrade multiparty service.
- c. Reinforce or replace existing plant.
- d. Reduce or eliminate subscriber held-orders.
- e. Serve uncertain growth areas.
- f. Fill temporary and emergency service needs quickly.

1.8 BETRS radio equipment is the ultimate in "movable telecommunications plant." It can be used for temporary service, permanent service, or to delay construction of conventional plant until service needs are accurately identified. BETRS equipment can be removed and reused as needs dictate.

1.9 Telecommunications service should be provided by utilizing the most cost effective facilities and technology. Economic planning strategies should avoid an all or nothing approach. Economic studies should begin with broad prove-in or breakeven determinations, and then be refined to consider a mixture of facilities and factors such as isolated pockets of subscribers and terrain. Economic studies should be made on appropriate competitive facilities and equipment. When BETRS radio is potentially competitive with other service techniques, it is recommended that economic studies include mixtures of copper, fiber, and radio facilities, and possibly the use of more than one type of radio equipment. There is generally no magic formula for the prove-in of BETRS radio equipment.

2. EQUIPMENT AND SYSTEM CHARACTERISTICS

2.1 Presently available BETRS radio systems range from dedicated channel analog point-to-point equipment and systems to trunked multichannel digital point-to-multipoint systems. In general, this discussion will emphasize universal application point-to-multipoint systems (analog or digital) with some discussion of point-to-point systems. Dedicated channel rural radio equipment is useful in select applications. It is not considered a system design tool for universal application and will be mentioned only briefly. The specific service requirements will determine the most appropriate BETRS system and/or equipment. The following components are used to describe BETRS radio equipment and system characteristics.

Base Radio Station is used to describe all equipment located at the BETRS central office radio terminal site. The FCC uses the term Central Office Station.

Repeater Radio Station is used to describe all equipment located at the BETRS radio repeater site. The FCC uses the term Relay Station.

Subscriber Radio Station is used to describe all equipment located at the BETRS subscriber radio terminal site. The FCC uses the term Rural Subscriber Station.

2.1.1 The FCC terms will be used in paragraph 5 and the generic descriptive terms will be used elsewhere.

2.1.2 In this discussion of BETRS radio systems, the term "repeater" refers to the retransmission of radio signals into a distant service area using a new set of radio frequencies different from the basic service area radio frequencies. The term "booster" is used to describe the reuse of the same radio frequencies as the base radio station to provide fill-in service into shadow areas within the basic service area. For purposes of FCC radio station authorization, a radio repeater is licensed as a "relay station" and a booster is considered under the basic authorization.

2.2 Point-to-Multipoint Systems: A point-to-multipoint radio system used to serve scattered individual subscribers from a common location is illustrated in Figure 1. Subscribers are served on a "trunked" basis where radio channels are shared and idle channels are available on demand by any served subscriber. All subscribers have access to any available channel. The advantage of this equipment is versatility. It is nearly universal in application. The disadvantage of this equipment is the relatively high startup cost for small systems. To be cost effective, common equipment costs are usually shared by a number of subscribers.

2.2.1 The base radio station equipment may be located in the central office building, or at a location some distance away. Part of the BETRS office terminal may be co-located with the central office equipment (COE), with the remainder of the office terminal (i.e., base radio) at a more appropriate radio service location. The two locations are usually connected by T1 span lines or digital microwave radio equipment. BETRS radio repeater stations can be used to extend service from the central office building to a single repeater radio station location or multiple repeater radio station locations to generally or selectively expand the service area.

2.3 Point-to-Point Systems: A point-to-point radio system used to serve subscriber clusters on a shared channel basis is illustrated in

Figure 2. The major advantage of this equipment is the shared common costs associated with both the office and subscriber ends. This includes power supplies, subscriber housings, etc. Several radio channels are used as "trunks" for a larger number of subscriber lines. Concentration ratios are determined by traffic requirements and system characteristics such as local switching (intraswitching) at the subscriber terminal.

2.3.1 Point-to-point cluster service may be provided by separate stand alone systems, or may be an option of point-to-multipoint systems. A common base radio station and shared use of radio frequencies may be practical with integrated point-to-point and point-to-multipoint systems. Otherwise, separate radio systems and channels will be required for each application, even with a common base station location.

2.4 Rural Radio Equipment: Point-to-point or "rural radio" equipment is used to serve individual subscribers on a dedicated channel basis. The major advantage of this equipment is the low startup cost to serve one or several scattered subscribers. It is similar in concept to the "add-on" one channel subscriber carrier. Rural radio equipment consists of frequency mated office and subscriber terminals. The radio frequency pair is pre-selected and fixed by the FCC. In general, the frequency cannot be reused within an exchange area. Frequency reuse (preselected and fixed) may be possible depending on the specific radio station locations and directional antenna orientation. The office terminal may be located at the central office equipment (COE) building, or may be located at the end of a cable route or other convenient location. The major disadvantage of this equipment is limited growth capability.

2.5 Radio Repeaters: Radio repeaters can be used with any of the above terminal equipment to extend the area of radio coverage. A BETRS radio repeater can be used to extend service from the CO building to a single base transceiver location in lieu of the office to base radio link described in paragraph 2.2.1. Radio repeaters can also be used to create multiple base transceiver locations to extend service over a wider area. The use of BETRS repeaters can increase the service area coverage and may reduce overall system costs. However, they may not be cost effective in most applications. The use of repeaters will also require additional BETRS radio frequencies. Frequency availability may be very limited in some areas. The use of repeaters to extend the BETRS service area is illustrated in Figure 3.

2.5.1 Another service possibility is to reuse and "boost" the base frequencies at a distant location. This is a form of "repeater" but is referenced here as a "booster" for clarification. Work is currently under way, and boosters may prove to be a cost effective method for fill-in service to shadow areas within the basic service area that cannot be reached by the base radio station. Control of the booster service area and control of co-channel interference within the basic service area is essential to success of boosters. Discussion of repeaters in this section is also intended to include boosters except for the technical differences concerning the FCC, frequencies, and service area coverage.

2.6 Miscellaneous Considerations: In the planning and design of BETRS radio systems, factors such as loop length from the subscriber radio station, power at remote terminal and repeater locations, remote housings, equipment accessibility, installation, and maintenance must be considered. Subscriber loop length may be short for service to individual subscribers,

but BETRS systems must generally be capable of 500 to 1000 ohms of outside plant (plus an additional 400 ohms for the telephone set) for cluster service applications. Reliable commercial ac power should be the first choice for primary system power if it is available. Solar power may be considered as an alternative for low power consumption repeater and subscriber radio stations, but may be too costly for high power consumption units. Physical access is important for all equipment, even the most reliable equipment.

2.6.1 Only single party (private line) BETRS radio equipment is considered.

While it is possible for the BETRS equipment to provide multiparty service, it is not recommended because of increased equipment complexity and cost. Conversation privacy should always be a consideration for fixed station BETRS applications. Privacy options are recommended for analog systems. Digital systems provide a degree of conversation privacy that is superior to analog systems.

3. PRELIMINARY PLANNING

3.1 Preliminary planning should begin with an up to date area coverage

survey (ACS) or similar subscriber survey. The planning and layout of a radio system is often done in incremental stages. A radio propagation study is essential. However, preliminary planning should be completed before the final radio propagation study is made. The following is suggested. Identify known and potential telephone subscribers in an exchange area or an overall service area. Is it practical to reach all subscribers by radio from the central office building or another common location? Is a radio tower already in place at the central office or other location? Is there a hill or other point of high elevation within the service area for the radio base station? If the radio base station is placed at one of these locations, will some subscribers be blocked because of terrain or manmade structures? What are the alternatives (such as repeaters or multiple base stations) for serving those remaining hard-to-reach subscribers?

3.2 Preliminary planning can be accomplished by using a common sense

approach. If a mobile radio system is already in place, it can be used to estimate the service area coverage with a BETRS radio system. If good to marginal service is available to all subscriber locations with the mobile system, directional antennas on towers at subscriber locations should provide improved service - in the same radio frequency band and the same transmitter power. The new BETRS system may use different frequency bands and lower transmit power than the existing mobile system. These differences may alter the service coverage area.

3.3 From topographical maps and visual inspection, pick a base radio

station location. Draw lines on the map from the base station to (a) the more distant subscribers, and (b) the subscribers with obstacles in the path. Either by sketch or by mental image, view some of the potentially difficult paths. Allow for growth of vegetation and potential building development. For example, would a tower of 100 feet at the base station and 40 feet at the subscriber locations provide a path above the path obstacles? The object of this review is to identify probable base station locations and to be relatively sure of adequate radio propagation (preferably line of sight) to most potential subscribers at an early planning stage. Figure 4 illustrates a simplified profile view of the radio propagation path between the base radio station and subscriber number 8 shown in Figure 1.

3.4 Review the costs and construction ease or burden for providing rural telecommunications service by using conventional facilities. Would new construction be economical using telephone cable, optical fibers, or digital microwave radio equipment? Is it possible or practical to apply digital or analog subscriber carrier (including distributed carrier) to existing cables? Consider the economics of using mixtures of BETRS and conventional facilities.

3.5 Power availability, cost and reliability at subscriber and repeater radio stations are important considerations in the planning and implementation of a BETRS system. Will commercial power be available, reliable and reasonable in cost? Is solar power a practical alternative to commercial power? Power for BETRS equipment should be considered in system economic studies and reliability calculations.

3.6 Review available BETRS equipment and compare with service requirements. Can the available equipment provide for initial service and projected growth? Will the system provide for traditional telecommunications service and standards? BETRS may be the only practical way to serve scattered rural subscribers.

4. RADIO SYSTEM DESIGN

4.1 Overview: During the system design and implementation stages, compliance with building, safety and electrical codes and approvals by REA, FCC, FAA and others are necessary. The suggestions and illustrations provided here are advisory. They serve only to illustrate the process of BETRS implementation. Early in the implementation process, approvals are required by REA for financing; by the FCC for radio station operation; possibly by FAA for tower construction; possibly by the Bureau of Land Management, US Fish and Wildlife, and State Historic Preservation on environmental impact; and possibly by other organizations in the enforcement of local, state and national codes. Part 17 of the FCC Rules covers tower height, lighting, painting and FAA notification. In planning tower locations, be aware of nearby airports, landing strips, and flight paths.

4.1.1 REA approvals are required for:

- a. Equipment: Generally must be REA Accepted.
- b. Plans and Specifications: REA Form 397 or 398 with appropriate attached specifications.
- c. Other stages of regulatory and financial approval.

4.1.2 In general, BETRS equipment must be REA Accepted (shown on the REA List of Materials or have REA Technical Acceptance). Exceptions are equipment placed on an REA field trial or waiver provided in special circumstances. The request for REA approval of Plans and Specifications and the request for FCC approval for Radio Station Authorization should occur at approximately the same time.

4.1.3 It is suggested that point-to-multipoint BETRS systems be designed for 99.9 percent availability. This permits a total down time of 8.8 hours a year to the average individual subscriber due to propagation conditions and equipment failures. Circumstances may dictate other design availability requirements.

4.2 System Design Considerations: A review of the quantity and location of subscribers to be served is the first order of business. Determine the most cost effective mix of BETRS and conventional telecommunications facilities. Determine if individual radio stations at each subscriber location is necessary, or if it is practical to share subscriber radio stations at common locations. Determine if cluster service to part or all subscribers is practical. Shared subscriber equipment is generally more economical than individual subscriber units. Determine if all subscribers can be served from one base radio station. If not, determine base radio station locations that minimize the number of base stations. Plan systems that eliminate or minimize the use of repeaters.

4.2.1 Determine the number of voice trunks and radio channels required to serve the subscribers (traffic calculation). Some BETRS radio systems require a radio channel for each voice trunk. Other systems subdivide the radio channel to provide up to 4 voice channels for each radio channel. Determine if the base radio station can be located at or very near the COE. If not, determine the most appropriate method of providing circuits between the COE and the base radio station (i.e., T1 span line, repeater radio station, etc.).

4.2.2 Determine the most appropriate power sources for subscriber radio stations, repeater radio stations, and any base radio stations not co-located with the COE. In general, this will be commercial ac power contracted with the local power company or the subscriber being served. In either case, attention must be given to local, state and national electrical codes for the safety of the general public and telco employees. Power for the base radio station located at the COE should be provided by the central office battery supply. Solar power may be appropriate for repeater radio stations and subscriber radio stations. Power consumption (idle and in use) and battery reserve calculations (8 hours recommended) for all sites are needed.

4.2.3 Electrical protection for equipment and safety of people require special attention where antennas are located. Generally, the higher the antenna above surrounding structures, the greater the exposure to lightning, and the greater the need for low resistance grounds and bonding connections. All exposed metallic surfaces (inside and outside cabinets) within the area require common bonding and grounding. Careful attention must be given to proper bonding and grounding at digital COE buildings to minimize damage to sensitive electronic equipment. The BETRS equipment manufacturer's recommendations concerning safety and protection should be followed. The manufacturer's recommendations should include surge protection for the ac power connection, antenna, and equipment interfaces.

4.3 Radio Propagation Study: After the sites for base radio stations are chosen (and radio repeaters if used), a radio propagation study is needed for each base station. Actually, two types of radio propagation studies are needed. A propagation study is required for the FCC using the Carey Method in FCC Report R-6406 (Technical Factors Affecting the Assignment of Facilities in the Domestic Land Mobile Radio Service, by Roger B. Carey, June 24, 1964). A survey using the Carey Method will show the general radio service area coverage and radio interference. However, the Carey Method is intended for Mobile Service with at least 90 percent coverage probability. An additional propagation study will be needed for reliable BETRS fixed service.

4.3.1 While BETRS is usually a point-to-multipoint application of equipment similar to mobile service, the subscriber stations are fixed. "Carey" or "Average" coverage does not ensure that each BETRS subscriber will receive reliable service. Therefore, the radio propagation study for reliable BETRS must include a point-to-point propagation study (similar to a point-to-point microwave path survey). A study of the path propagation between the base radio station and each subscriber radio station should be made. Requirements for base station antenna tower height, radio transmitter power (and effective radiated power), and individual subscriber station antenna tower height are determined from the study. Figure 4 is a simplified profile view of a radio propagation path. Factors such as earth curvature are not considered. Refer to engineering textbooks and to REA TE&CM Section 931 for information on radio propagation and path surveys.

4.3.2 Horizontal or vertical antenna polarization can be used for BETRS point-to-multipoint systems. Horizontal polarization for BETRS will provide some interference isolation from vertically polarized mobile system antennas. However, omnidirectional radiation patterns are easily obtained from simple vertically polarized antennas. Generally, BETRS systems will use omnidirectional antennas for the base radio station and directional antennas for the subscriber radio stations. Antenna polarization may be either horizontal or vertical, but must be the same for both the base and distant ends of a system. The antennas must be considered in the propagation study. FCC waivers are required for omnidirectional antennas and for vertical polarization in BETRS systems. Such waivers are routinely considered by the FCC, but must be requested in the application.

4.3.3 Questions about the radio propagation study and system responsibility are often raised. Will the Purchaser or Seller make the preliminary and/or final radio propagation study? In the case of marginal or unreliable service, is the Purchaser or Seller responsible for corrective action to achieve reliable service? The remedies and responsibilities may be different for minor system alterations to reach one or two subscribers than for major path and service problems found after equipment has been installed. These remedies and responsibilities should be clearly stated in the contract for BETRS. The contract should be one for a "Reliable System" or "Service," and not just a contract for hardware. System reliability and service should be defined quantitatively to the extent possible. System and service guarantees may prove costly in some cases.

5. FCC RADIO STATION AUTHORIZATION

5.1 BETRS is covered in Part 22 of the FCC Rules (Code of Federal Regulations, Title 47, Part 22) under the general heading of "Public Mobile Service. The FCC Rules require radio equipment Type Acceptance (equipment manufacturer) and a Radio Station Authorization (telco) to construct and operate a BETRS radio system. The applicant should be familiar with Part 22 of the FCC Rules and other referenced Rules and Reports. The following briefly highlights some aspects of the procedure and information required in the application.

5.2 When the application is ready to be filed, a call to the FCC Public Mobile Radio Branch may be helpful to clarify issues and avoid processing delays. The applicant may wish to seek specialized assistance and contract for filing the FCC application and search for available BETRS frequencies. Beginning May 21, 1990, all FCC submissions and applications

that require fees must be filed with the Mellon Bank in Pittsburgh, Pennsylvania, using an FCC Form 155. Submissions with fees that are filed elsewhere will be returned to the sender.

5.3 The Authorization process begins with an FCC Form 401, "Application for New or Modified Common Carrier Radio Station Authorization Under Part 22" filed with the FCC by the telco. At regular intervals, the FCC will issue public notice listings on applications (and other matters) to allow the public an opportunity to comment on FCC proposed actions. The Radio Station Authorization permits the BETRS system construction to begin. It specifies the construction start date and terms of the authorization. When construction has been completed in accordance with the radio station authorization, the licensee notifies the FCC on Form 489, Notification of Status of Facilities. BETRS service can commence the day that Form 489 is placed in the mail to the FCC. See 22.45 of the FCC Rules for the License Period. Reply by the FCC is not required. (FCC filings can be delivered to the FCC and receive a stamped record copy.) If construction is not complete within the terms of the authorization, the authorization will automatically expire unless an application for extension of time (FCC Form 489) is filed and approved by the FCC.

5.4 FCC Application: The Application for FCC Radio Station Authorization consists of a completed FCC Form 401 with attachments. Follow the instructions and furnish information specifically as noted. Some information must be in the space provided on the form while other information may be provided as attachments. The waivers, needs showing and other items discussed are routinely considered by the FCC for BETRS authorization. However, waivers must be requested and required information furnished in the FCC Form 401 application. Unless noted otherwise, the following discussion and comments apply to a point-to-multipoint BETRS system application.

5.4.1 The applicant should be familiar with the following FCC Part 22 Rules.

22.15(b)(1): Search for and list all co-channel stations within distances:

1-Way	35 MHz to 162 MHz	67 Miles
2-Way	152 MHz to 162 MHz	84 Miles
2-Way	450 MHz to 460 MHz	67 Miles
1 & 2-Way	Above height/power limits	125 Miles

22.15(b)(2): Interference studies may be made one of two ways:

1. Utilizing the Carey Method in FCC Report R-6406.
2. By using Class of station and Geographic separation listed in 22.502 and 22.503.

22.16(a)&(b): A Need Showing is required for radio channels. A maximum of four radio channels is normally granted with each initial application, and with each application for additions to existing systems. An application for more than four channels may be granted, but will require additional coordination within the FCC and may cause delay in the authorization.

22.108 & 22.110: Note antenna direction and polarization requirements.

A fixed station is required to utilize a directional antenna with horizontal polarization. Waivers are required for omnidirectional base station antennas and for vertical polarization.

22.600: Note that subscriber stations are generally covered under the base station authorization.

22.609: Note the supplementary showing required with applications for rural radio (BETRS) facilities.

5.4.2 FCC Form 401: One Schedule A is required with each Application. One Schedule B is required for each Antenna Location (generally base station antenna locations). Schedule A is straightforward and self explanatory. All exhibits that are attached to the application are listed on Schedule A (Item 22). Examples of attached exhibits are discussed based on the information requirements of Schedules A and B.

FCC Form 401 - Schedule A

Item 20: If the application requests one or more additional radio channels for existing service, a loading study (traffic study) is required.

Item 21: If the application requests more than one radio channel for new service, a statistical survey or other showing is required.

FCC Form 401 - Schedule B

Item 29: If waivers are requested, the exhibit must specify the FCC Rule(s) that apply and show good cause for each waiver requested. For point-to-multipoint BETRS systems, waivers must be requested for omnidirectional base station antennas and for vertical polarization of radiated signals (base and subscriber).

Item 37: The height and power engineering data requires special attention. Some data is required on Form 401 and exhibits may be required for other data. For example, 37(i) requires an exhibit if the antenna is not mounted on top of the antenna structure. Often an existing antenna structure will be used and the top of the structure is already used. An omnidirectional or other radiation pattern can be obtained, but an explanation is required. Effective radiated power and co-channel interference also require attention.

FCC Form 401 - Miscellaneous

Other attachments may also be required that are not specifically listed on FCC Form 401. For example, 22.601(a)(4) should be addressed to state that the applicant is authorized to provide BETRS (State certification or other authorization). Also, 22.609(a) requires a supplementary showing why it is impractical to provide the required communication service by means of wireline facilities. If relay stations are required, 22.601(b)(1) requires a showing why it is impractical to achieve the communications without relay stations (i.e., out of signal range of central office station). The application for relay stations can be filed with the BETRS application.

6. SYSTEM SPECIFICATIONS

- 6.1 Plans and Specifications: There are no BETRS equipment specifications by REA or by industry standards organizations, and no BETRS application specifications for attachment to REA contracts at this time. Appropriate specifications or benchmark references are needed for REA Acceptance (Listing) of BETRS systems, and appropriate equipment and application specifications are needed for REA financed BETRS purchases. Appropriate portions of specifications by REA, Bellcore, industry and manufacturers are usually referenced by REA, telcos, engineers and manufacturers. For example, Bellcore Generic Requirements for Basic Exchange Radio Systems (TA-TSY-000911) covers digital BETRS systems.
- 6.2 For REA financing, BETRS systems should be purchased on the REA contract Form 397 (or REA Form 398) with appropriate specifications attached to the contract. These performance specifications must be developed by the telephone company's engineer. The REA Form 397e, Mobile and Fixed Radio-telephone Specifications is useful as a guide (and only as a guide) for BETRS performance specifications. The 397e was intended as IMTS mobile radio system specifications with possible incidental use of fixed rural radio applications. It is outdated and incomplete as a BETRS system specification. The REA Form 397c, Design Specifications for Subscriber Carrier Systems is also useful as a guide for BETRS performance specification guide. Selected portions of REA specifications such as PE-64a (REA Bulletin 345-66, digital subscriber carrier) and REA Forms 397a through 397h might be helpful to the engineer in developing the BETRS specification attachments. Portions of traditional telecommunications standards and manufacturers' specifications for BETRS radio equipment can also be used. Specific target values and limitations should be stated in the contract. All parties must reach agreement on contract provisions before the contract is signed.
- 6.3 The BETRS specifications should be realistic and provide for reliable, high quality telecommunications service. In some cases, compromises may be required. In time, traditional performance parameters are expected to apply to BETRS without exception. Traditional transmission measurement techniques may not be adequate to verify some performance parameters of digital BETRS systems. Traditional transmission measurement techniques are analog in nature and may not be effective in testing new digital speech coding systems. In addition to agreement on performance parameters, Purchaser and Seller agreement may be needed on test techniques to verify performance.
- 6.4 BETRS Performance Specifications should be separated into four parts as illustrated below.
- Part 1: Basic BETRS System and Equipment Performance
 - Part 2: Installation and Acceptance Tests
 - Part 3: Detailed Purchaser's Requirements
 - Part 4: Seller's Proposal
- 6.4.1 For the basic BETRS system and equipment performance requirements, the format in REA Form 397e, Part I is suggested. Appendix 1 is an example of BETRS equipment specifications (partial list only) that might be attached to the REA Form 397. Appendix 1 is essentially a combination of selected standards and specifications from several sources including REA and the telecommunications industry. If manufacturers' specifications are used,

care should be taken to keep the specifications generic to the Purchaser's needs and not favor one manufacturer or equipment over another.

6.4.2 Installation and Acceptance Requirements should follow a format similar to the REA Form 397e, Part II. The specific details of installation and acceptance test requirements need to be updated with special attention given to both the office and subscriber locations. Proper bonding and grounding of antenna, equipment, and power is required to meet electrical and safety codes for the safety of people and protection of equipment and property at subscriber locations. Proper bonding and grounding are also important at locations of other modern electronic equipment including digital central office equipment. Attention must be given to antenna grounding and connection to other grounds external to the central office building; to the building entrance of ac power, telephone cables, and coaxial cables from the antenna; and to bonding and ground connections within the building. A suggested reference is REA TE&CM Section 810, Electrical Protection of Electronic Analog and Digital Central Office Equipment.

6.4.3 Detailed Purchaser's Requirements should follow a format similar to Form 397e, Part IIIA. These requirements should outline the specific system and equipment needs for BETRS service, and contain sufficient detail for a clear understanding of the Purchaser's requirements. Purchaser requirements and Seller responsibilities should be clearly stated in all parts of the Purchaser's specifications.

6.4.4 Equipment and service requirements should be covered in detail. General requirements and special requirements for business, data, paystations and other special applications should be stated. Outside plant loop resistance from subscriber radio stations should be stated. (For total drop resistance, add 400 ohms for customer premises equipment.) Major and minor alarm requirements for radio equipment and related requirements such as power systems and tower lighting should be stated.

6.4.5 The BETRS performance specifications should contain a Seller's Proposal Summary similar to Form 397e, Part IIIB. This should summarize the Seller responses to Purchaser requirements and serve as a quick reference check list that assures the Purchaser that the Seller is proposing a complete system to fulfill the Purchaser's system requirements. The Summary should contain a statement that the proposed system meets all Purchaser requirements, or note specific exceptions to Purchaser's requirements. The Summary should contain a checklist of detailed attachments by the Seller in response to the Purchase requirements.

6.4.6 The Purchaser's Requirements and the Seller's Proposal should each contain a Narrative. The Purchaser's Narrative should describe the initial and ultimate (growth) requirements for the equipment, system and service. The purpose of the Narrative is to outline the Purchaser's plans so that the initial equipment furnished under the contract can later be expanded to ultimate service needs with minimal impact. The Seller's Narrative should describe the proposed system(s), equipment, component parts, accessories, options and necessary test equipment. The Seller should also outline a plan for orderly growth from the initial quantities of equipment to the Purchaser's ultimate system requirements.

6.4.7 What options are available to the Purchaser if the FCC does not grant a radio station authorization, or grants authorization for less than the number of radio channels required for adequate telecommunications service (present and future traffic requirements)? Is there a termination clause or fallback provision in the contract?

7. SYSTEM PROPOSALS

7.1 It is recommended that the Purchaser seek proposals from at least three manufacturers (or Sellers) of BETRS radio equipment. Each Seller proposal should be reviewed for responsiveness to the Purchaser's contract provisions including the radio system plans and specifications. The lowest cost proposal that is responsive to the contract provisions should be selected unless there are valid reasons to select another proposal. The following proposal items should be noted.

7.2 Did the proposal respond to all contract provisions? Are some responses vague or inconclusive? Did the Seller take exception to some contract provisions? Are the exceptions logical? Are the excepted contract provisions essential to the service requirements, or do they substantially alter the service requirements or contract provisions? Is this a responsive proposal?

7.3 Does the proposal include adequate spare parts? Are the warranty provisions reasonable? Is the Repair and Return policy satisfactorily addressed? Has on-site and factory training been addressed? Does system maintenance require special test equipment? Does the telco have adequate general and special purpose test equipment for radio system maintenance?

7.4 Does the proposal include adequate documentation? The proposal should include equipment installation, operation and maintenance manuals, and final copies of drawings that outline selected options, special features, or other provisions.

7.5 Are the Seller installation and test responsibilities clearly stated? Are other Purchaser and Seller responsibilities clearly outlined in the contract? Has the proposal reinforced the responsibility provisions, or did the proposal raise questions in some areas? If the radio system fails to provide the necessary service, are the alternatives clearly stated? Does the Purchaser or Seller bear the cost if additional equipment or more costly alternative equipment is required for satisfactory operation? What limits are imposed on remedies and alternatives?

7.6 The Purchaser and Seller should reach agreement on all aspects of the contract before it is signed. Minor problems can become major problems when contract provisions are not clearly stated.

8. SYSTEM IMPLEMENTATION

8.1 If the planning, system design, FCC application, and contract provisions are thorough and complete, system implementation should be relatively smooth. Installation should be coordinated with all parties involved. The installer should be provided reasonable access to buildings, facilities and equipment, and be provided reasonable assistance by qualified telco personnel.

8.2 Installation should be monitored by a qualified telco representative.

Care should be taken to ensure that contract provisions are met and that the installation meets building, electrical, and safety code requirements. Special attention should be given to bonding and grounding at antenna locations, digital central office equipment locations, subscriber locations, and commercial power connections.

8.3 System installation should always include equipment and system acceptance tests. Acceptance tests serve to demonstrate equipment performance relative to contract provisions, and serve as a benchmark for later comparison and troubleshooting. Acceptance tests should include physical inspection, operational tests, and electrical tests such as radio frequency transmit level, receive signal strength, bit error rate, and voice levels. To the degree practical, radio fade margin tests should be made on radio stations with marginal receive levels.

8.4 A properly designed and properly installed BETRS system should provide telecommunications service that is equal to or better than wireline service. The subscriber should not be able to distinguish between service provided by BETRS radio equipment and traditional telecommunications facilities.

APPENDIX 1

EXAMPLE OF BETRS EQUIPMENT SPECIFICATIONS

This Appendix is an example of BETRS equipment specifications (partial list only) that might be attached to the REA Form 397. It is essentially a combination of selected standards and specifications from several sources including REA and the telecommunications industry. Care should be taken to keep the specifications generic to the Purchaser's needs and not favor one manufacturer or equipment over another.

1. GENERAL

- 1.1 Equipment interfaces to the telecommunications network, equipment, and facilities shall conform to traditional telecommunications analog voice frequency and signaling standards, or to D3/DS1 digital standards.
- 1.2 The equipment shall be designed for proper operation and interface with customer premises equipment registered under FCC Part 68. Customer premises equipment and material shall meet the Listing requirements of national and local codes.
- 1.3 The equipment shall be Type Accepted under FCC Part 22 and other applicable FCC requirements. Specific FCC Acceptance Designations shall be stated.
- 1.4 The radio equipment shall return to an on-hook condition (a) if the receive level falls below the minimum service threshold for more than five seconds; (b) within 5 seconds of subscriber on-hook or central office equipment disconnection; or, (c) within one minute for calls not completed.

2. ENVIRONMENT

- 2.1 Equipment mounted inside buildings shall operate satisfactorily within an ambient temperature range of 0° to 50°C and at 80 percent relative humidity between 10° and 40°C. Equipment mounted outdoors shall operate satisfactorily within an ambient temperature range of -40° to 60°C and at 95 percent relative humidity between 10° and 40°C.
- 2.2 DC powered equipment shall operate satisfactorily over a range of 44 to 56 volts unless stated otherwise. AC powered equipment shall operate satisfactorily over a range of 108 to 132 volts unless stated otherwise. AC powered equipment shall be equipped with battery backup for a minimum of eight hours operation.
- 2.3 Equipment power requirements shall be stated by the Seller at 50 volts dc or 120 volts ac input for minimum power conditions (low traffic or standby) and for maximum power conditions (high traffic, ringing, or in use).
- 2.4 Outdoor equipment housings shall be of rugged construction, corrosion resistant and designed to be water tight or weather resistant for good electrical and mechanical performance and to protect the equipment from damage or faulty operation due to moisture, dust and other airborne particles.

3. VOICE FREQUENCY

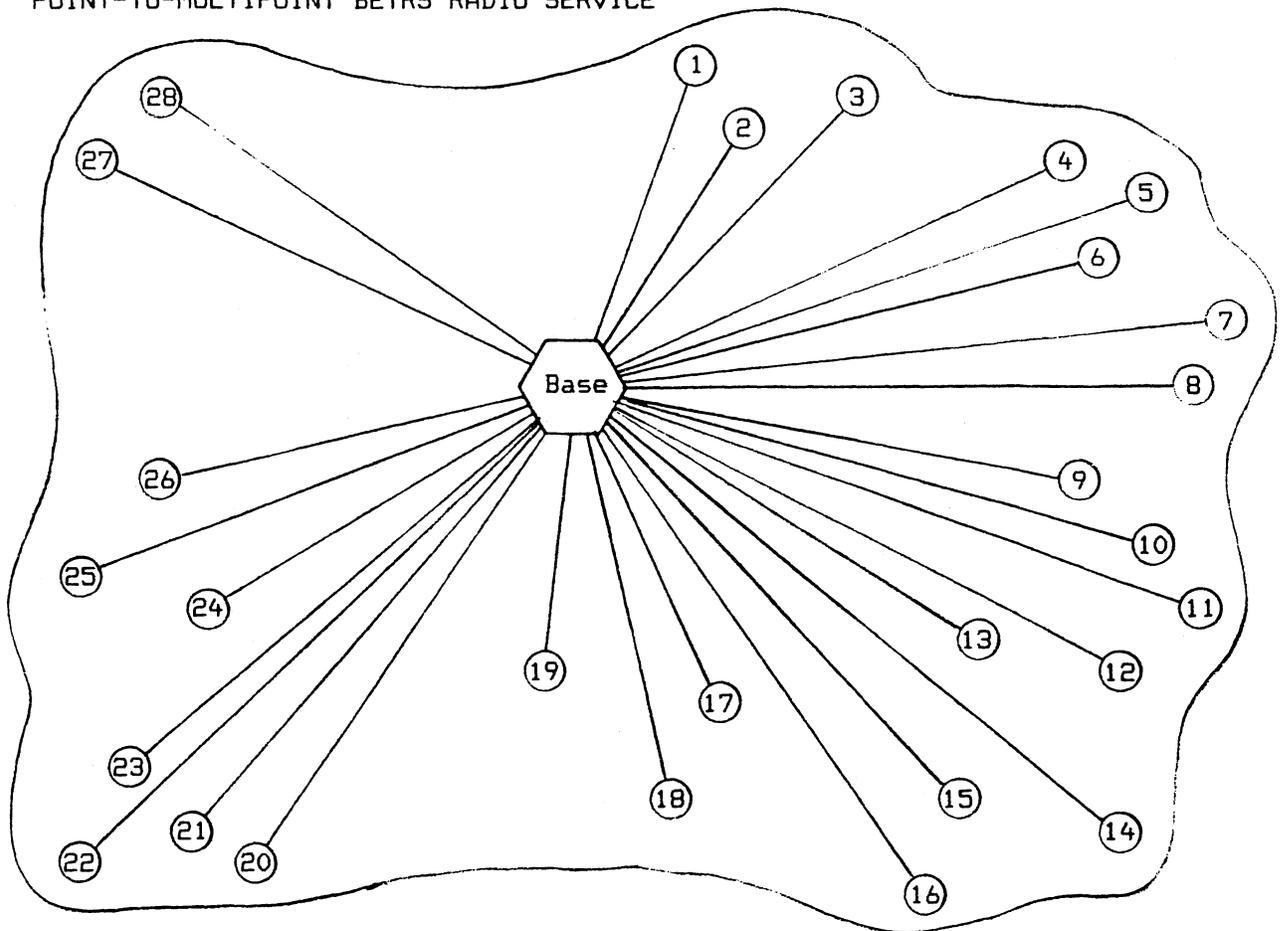
- 3.1 Impedance: 2-Wire: 900 Ohms in Series with 2.16 MFD.
4-Wire: 600 Ohms.
Minimum Return Loss:
From CO End: 18 dB ERL; 12 dB SRL.
From Subscriber End: 16 dB ERL; 10 dB SRL.
- 3.2 1004 Hertz Loss: Set at 2 dB; 1.0 dB Maximum Variation, Long Term.
Level Tracking: 0.5 dB Maximum Variation, From +3 to -37 dBm Input.
1.0 dB Maximum Variation, From -37 to -50 dBm Input.
Frequency Response Relative to 1004 Hertz:
+1 to -1 dB Maximum Variation, From 600 to 2400 Hertz
+1 to -3 dB Maximum Variation, From 300 to 3200 Hertz
-20 dB or Lower at 60 Hertz.
- 3.3 Circuit Noise: 20 dB_{BrnC} Maximum (Operational).
Signal to Noise: 33 dB Minimum, From +3 to -30 dBm Input.
27 dB Minimum, From -30 to -40 dBm Input.
22 dB Minimum, From -40 to -45 dBm Input.
Circuit Balance: 60 dB Minimum (ANSI/IEEE 455-1985).
Channel Crosstalk Loss: 65 dB Minimum.
- 3.4 Voiceband Data: 1200 Baud Minimum (4800 Baud Objective).

4. RADIO FREQUENCY

- 4.1 General: RF Channels Required _____
Maximum Bit Error Rate _____
Maximum Path Loss in dB _____
- 4.2 Base Station: Transmit Frequencies _____
Transmit Power Output (Per RF) _____
Effective Radiated Power (Per RF) _____
Minimum Receive Level _____
Receive Level Range (Min to Max) _____
Adjacent Channel Receive Rejection _____
Co-Channel Receive Isolation _____
Transmit to Receive Isolation _____
- 4.3 Subscriber Stations: Transmit Frequencies _____
Transmit Power Output (Per RF) _____
Effective Radiated Power (Per RF) _____
Minimum Receive Level _____
Receive Level Range (Min to Max) _____
Adjacent Channel Receive Rejection _____
Co-Channel Receive Isolation _____
Transmit to Receive Isolation _____
- 4.4 Repeater Station(s): _____

FIGURE 1

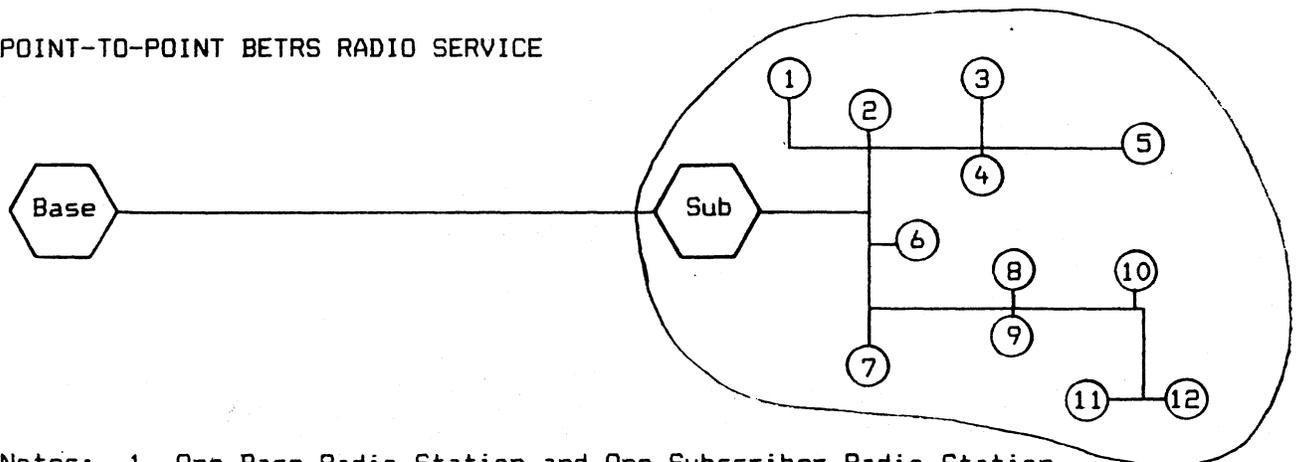
POINT-TO-MULTIPOINT BETRS RADIO SERVICE



- Notes:**
1. One Base Radio Station and 28 Subscriber Radio Stations.
 2. Requires Several Trunks or Channels (Radio/Voice).
 3. Subscriber Radio Station at Each Subscriber Location.

FIGURE 2

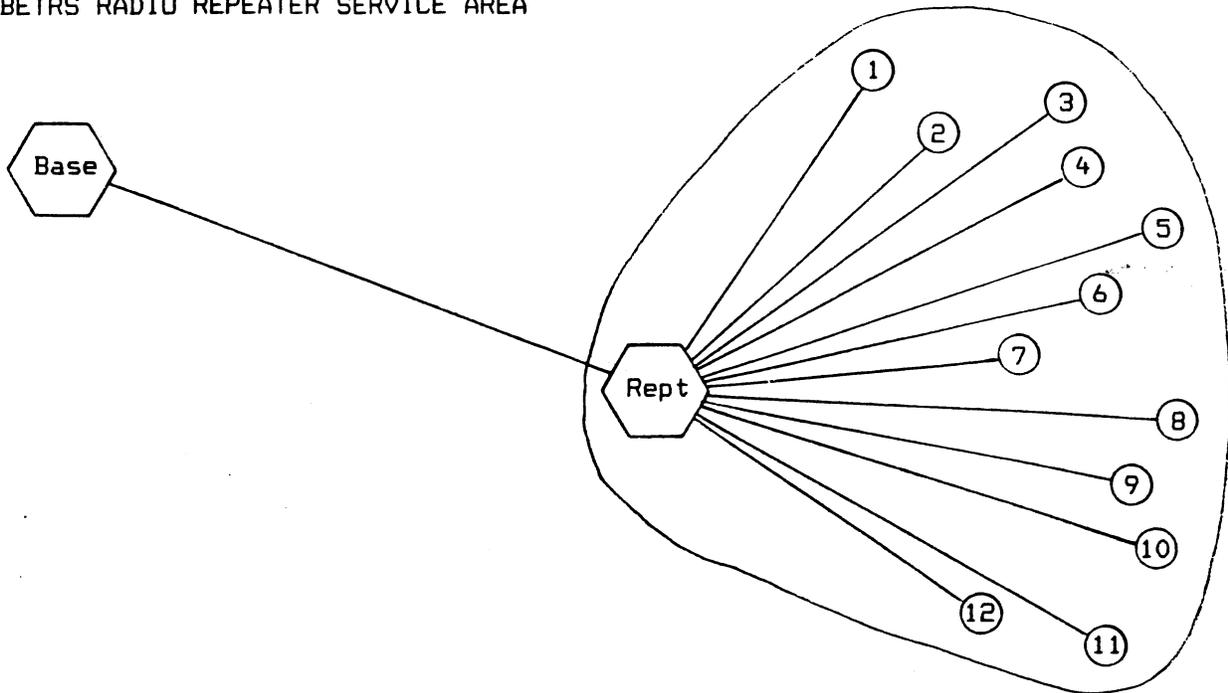
POINT-TO-POINT BETRS RADIO SERVICE



- Notes:**
1. One Base Radio Station and One Subscriber Radio Station.
 2. Requires Several Trunks or Channels (Radio/Voice).
 3. Conventional Multipair Telephone Cable to Subscribers.

FIGURE 3

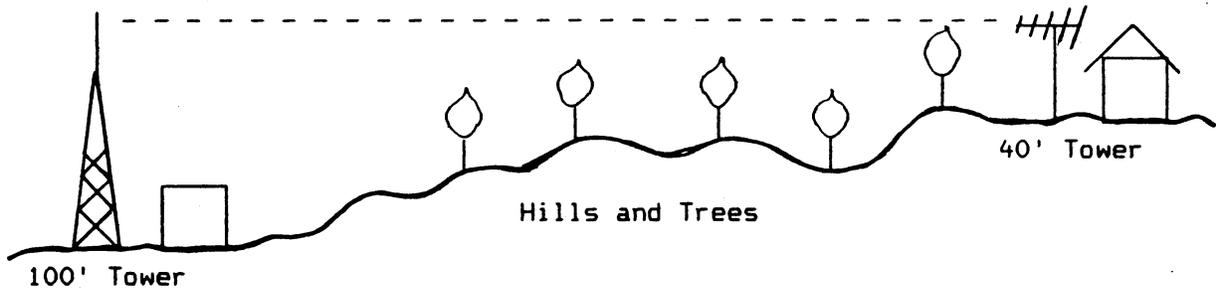
BETRS RADIO REPEATER SERVICE AREA



- Notes:**
1. One Base Radio Station, One Repeater Radio Station, and 12 Subscriber Radio Stations.
 2. Radio Transmission: Base to Repeater; Repeater to Subscribers.

FIGURE 4

SIMPLIFIED PROFILE VIEW OF RADIO PATH



Note: Simplified Profile View of the Radio Propagation Path from the Base Radio Station to Subscriber Number 8 shown in Figure 1.