# STATION CARRIER APPLICATION

PURPOSE: The purpose of this addendum is to summarize the application considerations of currently available station carrier equipment.

ADDITION:

## 1. GENERAL

1.1 Station carrier systems are designed to provide pair gain and reduce the amount of outside plant required. Station carrier is flexible in application and designed to eliminate the need for installation and maintenance adjustments for voice frequency loss, signaling, and carrier levels and equalization. In general, station carrier can be applied to any or all pairs of a cable; with minor exceptions, all types of station carrier can be mixed in a cable; and to a high degree, multichannel station carrier can be mixed with PCM carrier in a cable.

1.2 The following paragraphs summarize application considerations that are not covered in TE&CM Section 911, or that need emphasis or expansion. These are primarily (a) testing cables to determine cable suitability for carrier application; (b) locating repeaters at measured 35 dB intervals; and (c) observing limits on subscriber drop resistance, ringer quantities, etc. The application considerations are primarily directed toward multichannel repeatered station carrier; a brief note on one channel station carrier is covered in paragraph 1.4.

1.3 REA's serving area or SAVE guidelines are outlined in TE&CM Sections 230, 231 and 232. An economic comparison of pair gain electronics and cable should always be made when subscriber circuit reinforcement is required. Distributed station carrier is very beneficial where distribution cable pairs are not available. Where distribution cable pairs are available from a common field location such as SAI points in SAVE designs, grouped station carrier is more economical to install and maintain.

1.4 One channel station carrier application has changed little since it was first introduced. The guidelines in TE&CM 911 remain valid. They are nonrepeatered systems applied to less than 18 kilofeet (5.5 km) of nonloaded cable, within the maximum loss limits, and before the first repeater of multichannel systems in the same cable. Most types do not contain compandors, and cannot readily be mixed with PCM carrier in the same cable. (Note: It may be possible to apply one channel station carrier to cables with PCM carrier by selection of separate binder groups to improve cable crosstalk isolation. Other alternatives include the use of compandored one channel or multichannel station carrier.) Originally, one channel station carrier was designed only for inside mounting (distributed). Current systems are designed for inside and outside distributed application, and for groups of 20 to 50 units at one location. Inside mounted types generally provide for very short drop resistance limits. Grouped types provide for somewhat longer drops.

## 2. EQUIPMENT APPLICATION

2.1 Cable Measurements: For several years, REA has emphasized the need for testing cables (especially existing cables) to assure their suitability for carrier application. The stability of filled cables has reduced the concern about cable suitability; but certain cable and carrier system measurements are still required to assure low maintenance operation. Refer to REA TE&CM Section 921 for details on "Testing Cables for Carrier Application". Emphasis is placed on cable insulation resistance, shield continuity and attenuation measurements. Transmission reference data is contained in REA TE&CM Section 406 for air core and filled core cables.

2.1.1 Different cable construction materials and manufacturing procedures can yield different loss characteristics at carrier frequencies. REA cable specifications now contain attenuation requirements. But these requirements still allow for enough attenuation variation that longer systems must be measured to determine repeater locations. The 35 dB repeater spacing should be determined first by cable records, but finally by actual cable measurements at 112 KHz.

2.1.2 Station carrier was designed to be installed and maintained by less skilled craftspersons. Station carrier repeater gain-slope is based on 35 dB of 22 gauge PIC air core cable. When it is applied to other gauges and to filled core cables (introduced later), there can be significant carrier level variations through 3 repeaters. This level variation becomes worse on longer systems and with improperly spaced repeaters. This is a basic problem resulting from the fact that system imperfections such as level variation are cumulative for analog systems and add for each repeater section. Noise, crosstalk, false seizure, false ringing and other operational problems can occur if carrier levels become too low or two high.

2.1.3 Manufacturers offer a limited selection of loss-slope correction devices. Depending on the degree of slope correction required, these may be applied based on cable gauge (from cable records); or, more extensive carrier level measurements may be required to apply slope correction. The first step in minimizing carrier level variations is to establish repeater locations based on cable loss measurements.

2.2 Carrier Frequency Considerations: Since the introduction of station carrier, REA specifications have been written and updated to improve the compatibility of different types of station carrier and the mixing of PCM and station carrier within the same cable. There is one recent exception to this trend.

2.2.1 The latest revision of the REA station carrier equipment specification was written to accomodate both the existing systems and the new eight channel systems recently introduced by several manufacturers. The adoption of Primary and Alternate frequency standards do allow for some minor conflicts in the "universal" application of station carrier (mixing of different equipment).

2.2.2 The new eight channel systems meet the alternate frequency standards, and most existing equipment meet both the primary and alternate frequency standard. Some existing station carrier meets the primary standard but conflicts with the alternate standard. On occasion where an eight channel system (alternate standard) is placed in the same cable with a conflicting system (using primary standard), one or possibly two channels must be deleted from one of the conflicting equipment types. The conflicting frequencies are between 60 and 72 kilohertz. REA plans to identify station carrier as meeting the primary, alternate, or both frequency standards in the REA List of Materials (REA Bulletin 344-2).

2.2.3 In general, PCM carrier and compandored station carrier can be applied within the same cable. (All multichannel station carrier utilize compandors to meet the noise requirements of REA specifications. One-channel types may contain compandors, but generally do not.) Past study in this area was for station carrier frequencies up to 140 kilohertz. The new alternate frequency standard up to 168 kilohertz is not expected to affect the performance significantly.

2.2.4 The following criteria applies to the mixing of PCM and station carrier in small cables.

A. The station carrier systems must contain full range compandors that give approximately 25 to 30 dB compandor advantage. All multichannel station carrier systems on REA's List of Acceptable Materials are now required to meet this requirement.

B. The PCM trunk and subscriber carrier systems must use an encoding that limits the power on the span line at frequencies below 150 KHz. All D2, D3 and D4 encoded trunk and subscriber carrier are believed to meet this criteria. The REA List of Acceptable Materials now contains footnotes in the listing of digital carrier systems concerning these compatibility considerations.

C. The cables on which these mixed systems are applied must meet REA cross-talk loss requirements.

2.2.5 Mixed PCM and station carrier are applied as follows. Cable pairs are first selected for best PCM carrier performance. All remaining pairs can be used for station carrier application (compandored types only).

2.2.6 The guidelines above are based on PCM systems transmitting random bipolar signals of 1.544 megabits or higher; or transmitting repetitive patterns with a high pulse density to limit the power below 150 kilohertz. Certain digital systems (PCM or other digital types) may transmit pulses with bipolar violations, low density repetitive patterns, and/or lower bit rates. Pulses with these characteristics can shift the power to a lower frequency and cause interference with station carrier in the same cable. The effects of each of these systems must be evaluated before mixing with station carrier.

2.3 Power: Multichannel station carrier repeaters and subscriber terminals are powered over the cable pair. Except for extended length systems, the use of local ac power and batteries at field locations have generally been eliminated. To maintain this design and application philosophy of system power, certain limitations are imposed on subscriber drop resistance

limits, maximum number of ringers per system, etc. These limits vary with each system. It is important to apply the equipment within the design and application limits established by the manfuacturer.

2.4 Extended Length Systems: Station carrier systems were originally designed to operate over a maximum of three repeaters, or 140 dB at 112 kilohertz. Engineered on a special basis, station carrier systems have been applied to serve subscribers over 10 repeaters at more than 60 miles (97 km) from the central office.

2.4.1 Extended length systems require special engineering. The repeaters must be maintained more closely to 35 dB spacing. (Note: The "nominal" 35 dB should be at a "nominal" temperature so that at temperature extremes the loss remains "near" 35 dB. If cables are measured at mid summer or mid winter, temperature corrections should be applied to the measured data to determine "average" loss.) Extended length aerial applications are not recommended due to the large variation in loss from summer to winter. Standard repeaters might be used for 4 or 5 repeater applications; but special slope compensated repeaters will probably be needed for longer systems. Intermediate system power at a field location will likely be required also.

2.4.2 Properly engineered, these extended systems can provide reliable telephone operation. On very long systems, there is a possibility of some minor performance degradation (i.e., frequency response of one or more channels). But the overall transmission performance is expected to be superior to that of long physical circuits. The equipment should be purchased on REA Form 397c. Any degradation should be discussed by the Purchaser and Seller, and agreement reached (in writing) before the equipment is purchased and installed.

2.5 Reliability: Reliability requirements are now included in all carrier equipment specifications. Manufacturers include a burn-in of equipment as a part of their quality assurance program. This has eliminated the need for on-site burn-in as referenced in earlier publications such as TE&CM Section 911 and REA Standard PC-4.